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AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION

ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY 505 PEARL ST. NEW YORK

Vol. 33 Index to Advertisers and Classified Index Following Reading Matter No. 1

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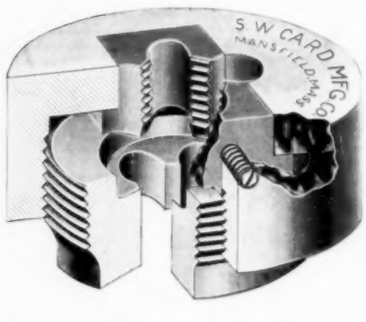

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513	1, 1/8, 1/4, 1/8, 1/2, 1/8, 1/4, 1/8, 1, 1 1/4, 1 1/2	2–3 1/2"	16–38"	8–10	40.00
514	1, 1/8, 1/4, 1/8, 1/2, 1/8, 1/4, 1/8, 1, 1 1/4, 1 1/2	3–3 1/2"	31–38"	10	37.50
515	1, 1/8, 1/4, 1/8, 1/2, 1/8, 1/4, 1/8, 1, 1 1/4, 1 1/2, 1 3/4, 2	2–4 1/2"	16–52"	8–10	60.00
516	1, 1/8, 1/4, 1/8, 1/2, 1/8, 1/4, 1/8, 1, 1 1/4, 1 1/2	2–3–3 1/2"	13–15–16"	8–10	42.00
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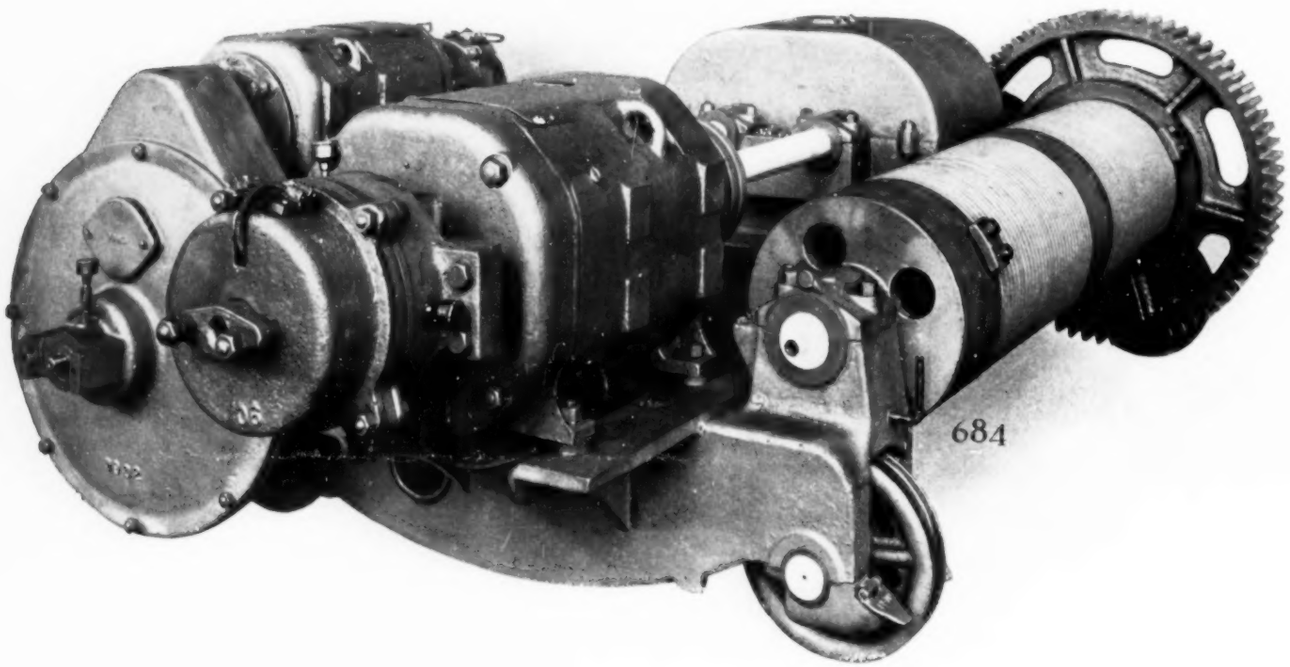

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(*See pages* 51, 52, 53, 54, 55, 56, 57 *and* 58)

A SUCCESSFUL SYSTEM of APPRENTICESHIP

Features and Results of General Electric Co's Plan of Training Mechanics

BY F. A. HALSEY

Now that the impossibility of obtaining an adequate number of boys for machine-shop work has become practically universal, it is worth while to sit up and take notice of methods of which the outgrowth is that boys fairly stand in line waiting for a chance to get in. This is the more remarkable if we bear in mind, that while most shops have been compelled to give up making any binding agreement, in the cases referred to, the boys are not only anxious to get in, but to sign papers for four years' service as indentured apprentices. Moreover, while in most shops such a thing as an educational qualification is not so much as thought of, in the cases to be described such a qualification, together with a term of trial service of two months is exacted, and the standard of admission is so high that not less than 50 per cent. of the applicants are ultimately rejected.

Apprenticeship systems were organized at the Schenectady works of the General Electric Company, in 1901, and at the West Lynn works, in 1902. The plan described below, including separate training rooms and school rooms for class-room work originated at the West Lynn works and, as a result of its success there, it was carried to Schenectady in October, 1908.

Many references to this work have already appeared in these columns, but the difficulty of obtaining apprentices has become so widespread and the necessity for training apprentices has grown so acute that it has seemed worth while to look into and publish an account of the work, because there can be no question that the methods followed do obtain a superior class of boys and that they do make them into superior workmen.

Essentials of the Plan

The essentials of the plan, which I do not need to remind the readers of the American Machinist is due to M. W. Alexander, are twofold: The boys receive their initial training in a special department called a training room where the work is selected from the general work of the factory in reference to its educational value and is performed by the boys under the eye of skilled instructors; and, along with this, provision is made to conduct, during shop hours, a series of classes similar to those in the public schools, except that the subjects taught have direct relation with the factory work.

The Requirements

The boys at West Lynn are required to have passed through the grammar school, or to have reached an equal stage of proficiency. In some cases boys apply who have acquired the requisite knowledge in evening schools or other educational institutions, and such boys, being the last ones to be rejected if their educational equipment comes up to the required standard, are accepted after a successful examination to determine their proficiency.

There is also a rigid selection based on the personality of the applicant and his adaptability to the work. Following his provisional acceptance he is given a two months' trial term, at the end of which period if he proves to be satisfactory and should he still wish to sign the indenture papers, he is accepted as an apprentice. This, however, does not mean that his acceptance is beyond recall, as he is subject to discharge at any time should it become clear that he is not fitted for the work.

At the Schenectady works where A. L. Rohrer and F. J. Trinder have charge of the apprentice training, the educational requirements are, as yet, less strict, the boys being required to pass an examination in arithmetic including fractions and decimals only, and preference is given to the sons of employees. In other respects the methods of selection at Schenectady do not differ much from those at West Lynn.

The Number of Apprentices

The West Lynn system was started in 1902 with a single training room of about 1500 square feet of area. It has grown, until today, the training room for patternmaker apprentices alone covers an area of about 4000 square feet, while the machinist apprentice training rooms occupy a space of over 13,000 square feet. Arrangements are now being made to add to this a further space of about 7000 square feet and an additional equipment of machine tools for it is being installed.

The total number of boys who have completed the four years' course at West Lynn stands at 101; of these, 61 are now employed by the company, of whom 7 hold positions at the works as assistant foremen, 5 as inspectors and 12 as jig and fixture designers and draftsmen, the remainder serving as skilled mechanics. Many of these will, no doubt, be advanced to responsible positions within a few years.

At Schenectady one of the apprentices who is not yet out of his time, has shown such aptitude for a special class of die work that he is already slated for a position of gang boss in charge of the work when his term is completed.

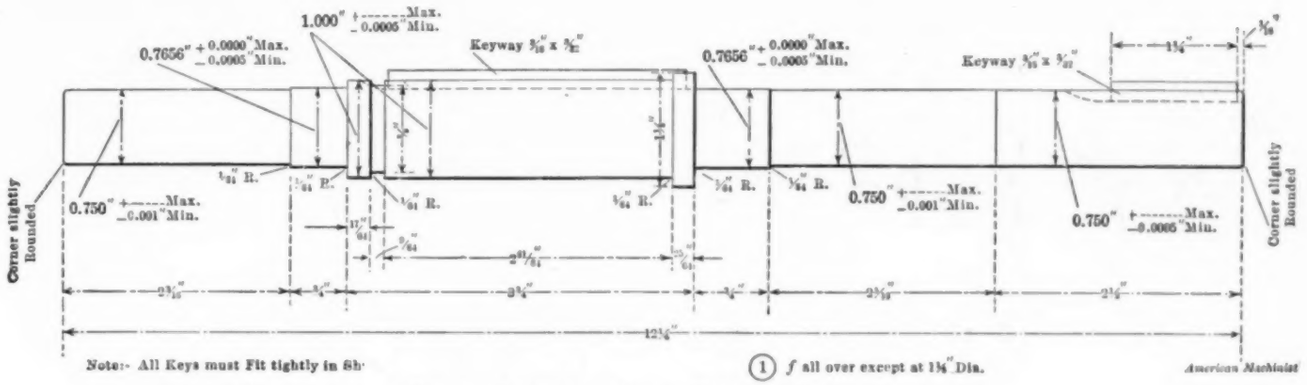


FIG. 1. ARMATURE SHAFT MADE BY APPRENTICES

Of those who have applied for positions and have been rejected without trial no record has been kept, but the strictness of the selection and the popularity of the work are sufficiently shown by the fact that since 1902 only 557 have been allowed to sign the regular agreement, although over 1000 were admitted to the trial period. Of these 557 indentured apprentices 101 as stated, have graduated; 124 were dismissed after the signing of the contract because they were found to be not adapted to the work; 50 were discharged for other causes, such as insubordination and so forth; 84 broke their contracts, and 39 were released because of sickness, removal to other localities, going back to school and other good and sufficient reasons. To come down to more recent figures, 257 were provisionally accepted and started on the trial term between January 1 and November 1, of whom 147 have failed to satisfy the requirements, leaving 110 still at work in the training room, of whom some of the more recent ones will no doubt drop out. There are at present 212 apprentices in training at the West Lynn works. The total number of boys who have completed their time at the Schenectady works is 347, of whom 223 are now employed in the shops.

Prior to the reorganization of the Schenectady school, in October, 1908, the works had taken apprentices on the old lines and 395 apprentices were in the shops at that time, and 79 in the drawing room.

The increase of those who have passed the trial term and have been accepted beginning with last April is shown by the following table:

April	364
June 1	376
Oct. 1	396
Nov. 1	400

During this interval a total of 129 boys have applied for admission, and, as shown above, 36 were permitted to sign the agreement. In addition to these, 21 are now undergoing their preliminary trial, while 37 have passed their examination and are on the waiting list. Eleven others failed to pass the examination but appeared to be of so promising a character that instead of being rejected outright, they were promised another chance.

These figures are given at length because they show better than any general statement could that here is a system of apprenticeship that is in such demand as to permit rigid requirements and close selection.

At the West Lynn works there is practically no waiting list of good candidates because the system has long been accepted there as a successful enterprise and instead of keeping a waiting list it is the policy of the company to enlarge the accommodations for the school precisely as they would enlarge any other department of the works as rapidly as enlargement is called for. The contemplated addition to the training room above referred to is an illustration of this policy.

Economy of the Apprentices' Work

So much for the success of the system in accomplishing its main object; namely, the attracting of desirable boys. When it comes to the second and nearly as important point; namely, the cost of the work done by the apprentices, no such clean-cut exhibit of figures can be made.

C. K. Tripp, who is in direct charge of the practical training of the apprentices at the West Lynn works is more than ordinarily prolific of ideas and frequently uses different methods of manufacture from those ordinarily employed, although the work done in the training rooms is identical with that done in the main works. This with other causes makes it impossible to present a comprehensive showing of the cost of the work based solely on the efficiency of the apprentices, and, for the present purpose, no other comparison would be satisfactory.

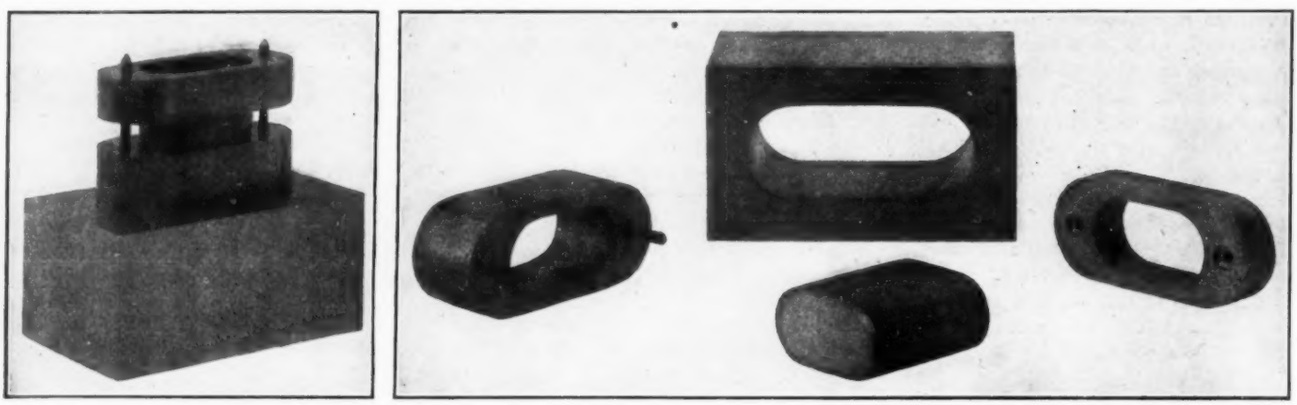


Fig. 2

Fig. 3
Molds Made By Apprentices

It may be said, however, that the General Electric Company is entirely satisfied with the results achieved. Seven years of experience have demonstrated that an apprentice system, developed on broad and sound lines and ably managed, is no source of expense to the manufacturer although this point is, of course, one of secondary importance, the proper training of skillful and intelligent mechanics being always the main object of the system. It should be added that this conviction is contrary to preconceived ideas, Mr. Alexander having had to use some persuasion in getting the company to give his plan a trial because of the belief that it might prove rather costly, and the successive increases in the size and equipment of the training rooms are the direct result of the demonstration that the system is not a tax on the company.

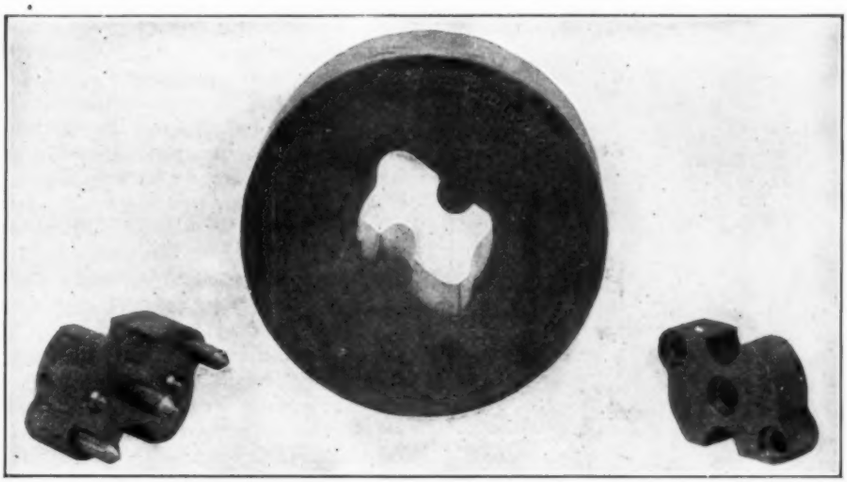


FIG. 4

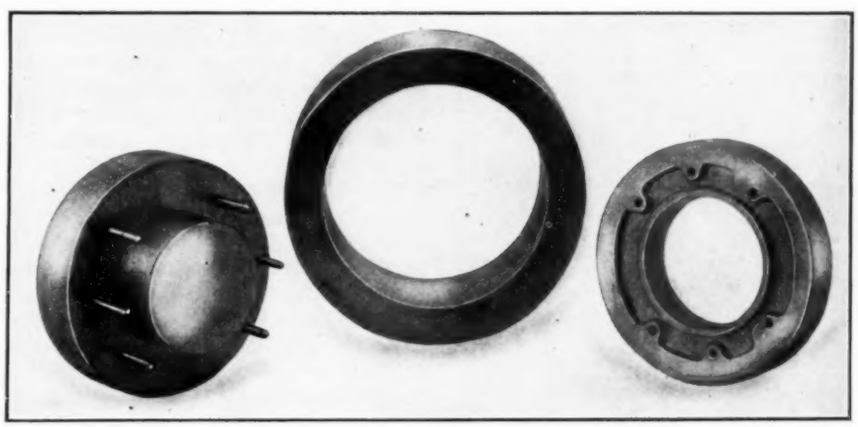


FIG. 5
ADDITIONAL EXAMPLES OF HIGH-CLASS MOLD WORK

SOME OF THE WORK DONE

The third leading point to be considered is the success of the school in training efficient workmen, and here again, fortunately, we can get close to facts which are just as good as figures. The products of the training rooms go to the assembling department with the products of other departments, passing the same inspection on the way. I discussed the subject of the quality of the work with the inspector, and was told that the percentage of the rejections of the products of the apprentice department is smaller than that of any other department of the works.

To get still closer to figures, Fig. 1 shows an armature shaft of which a large number were just passing the inspector's hands on the occasion of my visit. The engraving is from a working drawing and is given to show the limits to which the work is done. The common fractions indicate scaled dimensions, while the decimals call for the use of the micrometer.

An accurate account of the number of similar pieces passing the inspector's hands during an entire week shows that of a total of 1323 shafts 34 were rejected—about 2½ per cent. Similarly of 173 cast-iron pulleys of various sizes below 15 inches 5 were rejected, and of 312 clutch armature parts 2 were rejected. It should be remembered, however, that the fact that a piece is rejected does not necessarily signify that it is spoiled. In the case of lathe and grinding-machine work, especially, the tendency is for pieces to be too large rather than too small, and when rejected because too large they are, of course, sent back to the apprentices and the errors are corrected. That was the case with all of the pulleys and most of the shafts.

I found plenty of other illustrations of the high quality of the work turned out by the apprentices. Figs. 2, 3, 4 and 5 show, assembled and disassembled, various molds for the production of special insulating pieces made of a suitable compound and under pressure.

In the case of Fig. 2 the mold consists of a confining die with two oblong rings through which steel pins pass and a central plug. It will be seen that the rings may, if the workmanship is good enough, be reversed with respect to one another and also with respect to the plug and outer die, making a total of eight possible combinations in which the entire mold may be assembled, and when these reversals are made the parts fit regardless of the manner in which they are assembled.

The same thing is true of Fig. 3, in which the reader will note the increased severity of the test due to the increased complexity of the outline. Fig. 4 shows a mold of still more complex outline, such indeed that only a single reversal is possible, but in this test it makes good. Fig. 5 shows still another mold with which only a single reversal is possible, although this involves fits by the six dowel pins. This mold is shown chiefly because of its character, which is that of the die sinking, and one must go far to find a better piece of die sinking than it.

I made the necessary trials to convince myself of the reversibility of the pieces and can vouch for the facts as stated, and as regards the character of the fits, no one can say that they are not first class. The molds are, of course, of steel throughout.

Similar exhibits by manual-training schools, made without regard to the time expended, are not unusual, but these tools differ in that they were made as a commercial proposition, and because experience has shown that the boys make them as well and as cheaply as the regular toolmakers.

It is not, of course, pretended that all of the apprentices acquire sufficient skill for such work, though all who are capable are given the opportunity. The shafts and pulleys were all made by apprentices of less than one year's service and the molds shown were all made by apprentices of about two years service, and are but few of many that might be shown.

Figs. 6 and 7 show two multiple-spindle drill heads made by the apprentices. The drill spindles are located in concentric circles, there being 22 spindles driven by a complicated nest of gears in the heads and with these drill heads there go appropriate jigs as shown. The grouping

of the spindles is such that but four changes of location of drill head and jig are geometrically possible but those changes may be made as in the case of the molds.

No effort has been made to obtain samples of work of apprentices who have already finished their time in the training room and are now working for the remainder of the apprenticeship with and among the regular journeymen in various departments of the works, for it might be claimed that such work represents the joint efforts of mechanics and apprentices. No such claim can, of course, be made relative to work performed in the training rooms, as there are no journeymen working in these places.

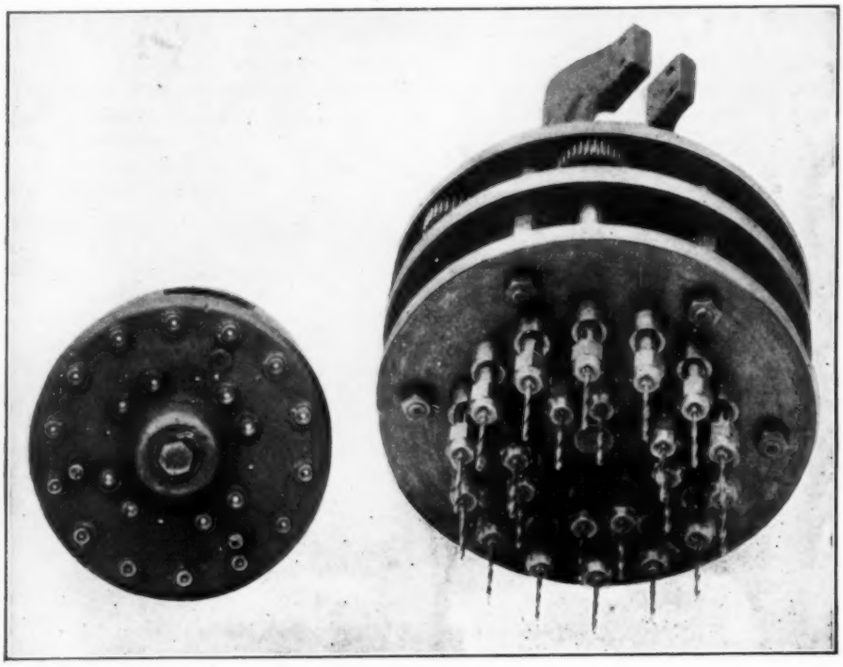


FIG. 6

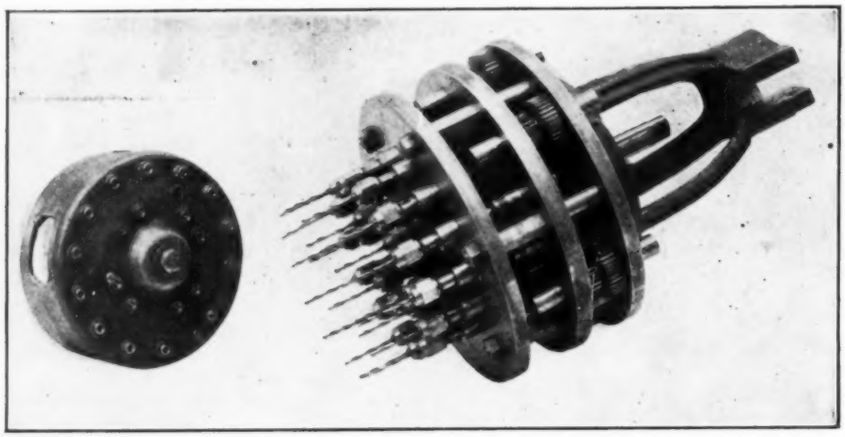


FIG. 7
MULTIPLE DRILL HEADS MADE BY APPRENTICES

PROGRESSIVE ORDER OF THE INSTRUCTION

The work done in the training room is classified, the first part being devoted to the making of cast-iron parts of the various products of the company. Naturally much, though by no means all, of this work is of a character which requires only a moderate degree of skill, as, for example, the making of pulleys, which are done strictly by manufacturing and highly novel and interesting methods. Other parts, as for example, those of a friction clutch, of which the company makes much use, are finished on the grinding machine and between close limits.

The second part is devoted to the manufacture of steel parts, including many small shafts for motors, which are ground to close limits, one of the first things that struck my eye being a boy of less than three months' term of service, who was operating a Norton grinding machine with the air and manner of a veteran and doing work within limits of a quarter of a thousandth.

The third part, which is the largest of the three, is devoted to work of a more general character, including much jig and tool work, of which the molds and drill heads already shown are examples. One of the most recent products of this room is a vertical precision tool-room milling machine, of which the general design is due to Mr. Tripp, while the drawings, patterns and all machine work are the products of the apprentices. This machine has proven so useful that other factories of the company have ordered duplicates of it, which are now in progress. It will be illustrated in these columns in the near future.

The work to be done in the additional space referred to, is to be similar to that already mentioned, although it will probably include more complete examples of manufacture of assembled elements of complete machines.

APPRENTICE TEACHERS

The cost of instruction in the practical work has been greatly reduced by a plan which has proved to be so successful that it is looked upon as one of the most important of the methods followed.

Instead of every operation being taught to each boy by a regular instructor, the plan makes each boy a teacher of the one who follows him on a given piece of work, his own promotion being dependent upon his ability to start his successor off successfully in his own footsteps. Of course, the regular instructor follows these teams from time to time to make sure that the work is done in the proper manner. The day I was there a dozen examples of this practice were before my eyes.

This plan is found to cultivate thoroughness and a certain pride which is natural to the teacher's function and to a large extent to develop any latent foremanship talent which an apprentice may possess. It might be supposed to introduce and perpetuate erroneous and even slipshod methods, but the fact that a regular teacher supervises it all, makes it impossible for errors to go very far before they are discovered, and, of course, when discovered, the teacher apprentice is the one who gets called down.

In this connection it should be added that derangements of the machine tools are handled by the boys to the extent that they are required to locate the trouble, and if within their power to fix it. This plan is adopted because of its importance in familiarizing the boys with the machines, and it thus assists in making them independent mechanics and not mere operatives.

A noteworthy feature of the training rooms is their remarkable neatness. This is exacted as a part of the training of the apprentice in proper habits, and as a matter of fact, a watch factory could

scarcely be kept in better order than the training rooms. Another feature which was adopted for its educational value is the use side by side of line shaft and individual motor driving with appropriate layout lathes of the former class being arranged parallel with the side wall and those of the latter perpendicular thereto.

One of the most pronounced and gratifying developments of the work is the number of applications from the sons of workmen, foremen and other officials of the company which are regarded as a high indorsement of the value of the training given. A large number of applications are also received from sons of tradesmen who deal with the company and also come in contact with the general public. It appears that parents with sons on their hands often apply to these men for places for their boys, and by placing before them the opportunities offered a large number of such inquiries have been directed to the school. Many others have come through the Young Men's Christian Association, public-school principals and superintendents and customers of the company.

Wages Paid and Terms of Service

The wages paid at West Lynn are as follows: First six months, 8 cents per hour; second six months, 10; second year, 12; third year, 14; fourth year, 16½, with a bonus of $100 at the completion of the term.

The machinists', patternmakers' and molders' trades are taught primarily, although limited opportunities are also offered for instruction in steamfitting, tinsmithing, blacksmithing and a few other minor trades. Apprentices in blacksmithing and molding receive somewhat higher rates than the others.

While the length of the term is four years, it is not all spent in the training rooms. After acquiring a reasonable degree of efficiency, the boys are frequently "loaned" to other departments of the works as helpers, or to supply a temporary vacancy or need, and after about 2½ or 3 years in the training rooms, dependent on individual capacity, the apprentices are regularly transferred to the other departments where they work alongside of the regular force of workmen, but still under the control and direction of the superintendent of apprentices.

No account has been taken here of boys who wish to prepare themselves for careers as machine draftsmen and designers. At West Lynn only high-school graduates are admitted as draftsman apprentices for a course of three years at a compensation of from 10 to 20 cents per hour. Half of this time is spent in the shops and the remainder in the drawing office.

At Schenectady both high-school and grammar-school pupils are admitted as draftsman apprentices, the course lasting four years at regular apprentice wages, and about a year being spent in the shops, the remainder in the tracing and drafting departments. The differences in the systems at West Lynn and Schenectady are partly due to local conditions, the West Lynn works being so situated in reference to school population, that stricter requirements of admission and a higher standard of work can be more readily enforced. The underlying principle, however, is the same—skill and industrial intelligence combined can only make the right kind of mechanic and give him the foundation for future activity as foreman and superintendent.

The Class-room Work

At both the West Lynn and Schenectady works several class rooms are fitted up very much like ordinary school rooms, and to the work done in these rooms 7½ hours per week at West Lynn, and a somewhat smaller amount at Schenectady are devoted, the work being done during shop hours and the apprentices being paid for the time spent in the school rooms precisely as they are for that spent in the shop. The subjects taught—always with strict reference to the work going on—are arithmetic, algebra, geometry, plane trigonometry, drawing and physics, the last including mechanics and electricity.

At first sight this seems like an ambitious program for the amount of time available, but 7½ hours a week stretched through almost four years is sufficient for the accomplishment of a good deal, and in addition to this special influences are at work. Professor Schneider has found, in connection with his coöperative plan of engineering education, that the coöperative students do as much school work in one-half the total time as the regular students did in the entire time, and the more recent experience of the coöperative plan as applied to industrial education at Fitchburg, Mass., of which we shall have more to say later, tells the same story. With the alternation of work between the physical and mental, each, no doubt, acts as a vacation for the other. They provide that variety which boys want and need, and insure that the school work is done with bright, unwearied minds and without the possibility of its becoming a piece of drudgery. In addition to this it must be remembered that the boys are picked boys, and that the constant question of the young mind, "What is this good for?" finds here always a ready answer, the fact that the problems given relate directly to the work in hand adding another stimulus. If the coöperative work at Cincinnati and Fitchburg tells a true story, then these 7½ hours per week are nearly, if not quite, equivalent to 15 hours in the usual public school, and it is entirely clear that in estimating the amount of work that can be done in the time available, in comparison with the work done in public schools, the value of the hours spent upon it should be considerably increased.

Examples of the School Problems

Instead of attempting to describe in general terms the kind of problems that are put before the boys in the class rooms, I have thought it best to give a few examples of those problems. Some of those which follow are taken from the works at West Lynn and some from that at Schenectady:

A molder receives $18.75 for molding 480 lamp bases. What is the cost per pound for the molding if the average weight of each lamp base is 18¾ pounds?

A molder receives (a) dollars for molding (b) lamp bases. What is the cost per pound for the molding if the average weight of each lamp base is (c) pounds?

In the last problem let (a) = $16.72, (b) = 493 and (c) = 8⅛. What is the cost per pound?

This method of first presenting a problem in concrete numerical form, then in the general or algebraic form, and finally of solving an arithmetical case by algebraic methods, is very generally followed at West Lynn, being in fact a feature of all the following problems taken from that place, although, having given one example of it, it seems unnecessary to repeat the illustration.

It is desired to shrink-fit a pin into an iron casting so that when the casting is heated to a cherry red it will slip on the pin and when cold will be a tight fit. Allowing 0.001 inch per inch diameter of pin for shrinkage what size hole will it take for a pin 2 3/32 inches in diameter?

The forward speed of a planer is 25½ feet per minute and the tool advances ⅛ inch across the work per stroke. The back stroke of the planer is ⅓ faster than the forward stroke. Assume the forward stroke to be 26 inches and the width of the piece being planed 11¼ inches, and figure the approximate time to plane the work once over.

With good quality of coal the average steam consumption is 1¾ pounds per indicated horsepower per hour for a 1400-horsepower triple-expansion engine running condensing. How long will it take to consume 250 tons of coal provided the engine averages a 14½-hour run for each 24 hours?

A punch and die are to be made for punching ⅝ inch diameter hole in boiler plate 3/16 inch thick. Allowing a total clearance of ⅛ the boiler-plate thickness between the punch and the die, what is the diameter of the die hole?

An order is received for 320 switch plugs, the metal part to be of brass rod, ⅜ inch in diameter and of dimensions shown in the sketch.* How many feet

*Sketch omitted.

of stock will be required, allowing 1/16 inch for cutting off? How many rods 6 feet long will be required? How many inches of material will be left over from each 6-foot length? How many inches will be left over from the last rod? If ⅜-in. brass rod weighs 0.395 pound per foot how many pounds will be required for the above order? If this material costs 16 cents per pound what will be the total gross cost of the material?

A 2-horsepower, 1100-revolution per minute motor, fitted with a 3½-inch pulley drives an 18-inch emery wheel, fitted with an 8-inch pulley. What is the speed of the emery wheel in feet per minute? For the same size pulley and speed of motor what would be the speed per minute of a 24-inch emery wheel?

A Le Blond lathe having the general arrangement of gears shown in the sketch* and the pitch of the lead screw being six what thread will it cut? Having the same arrangement except that the screw gear is not known what gear shall we use in order to cut a screw of eight threads per inch?

Desiring to turn a pulley 4 inches wide, 6 inches diameter at the crown, 5¼ inches diameter at the edge on an arbor 10 inches long what is the taper per foot? How far must the tailstock be set over when using an arbor 12 inches long? How far must the tailstock be set over when using an arbor 8 inches long?

These examples could be multiplied indefinitely but those given are sufficient to illustrate the spirit and purpose of the class-room work. In view of the fact that in many cases the various pieces referred to in the problems are made in the training rooms, the manner in which each kind of work acts to stimulate interest in the other is self evident.

Comments on the Results

In connection with this work two facts stand prominent: First, the rapid acquirement of skill, and second, the remarkable amount of work done. To me the first is not surprising. Between the methods used here and those which commonly obtain, there can be no comparison. The fact is that the world knows but little of the possibilities of systemmatic trade teaching or of the rapidity with which skill may be acquired under deliberate teaching with work so taken up as to present a suitably arranged and graded series of exercises. Such experience as it has leads one to accept the rapid acquirement of the ability to do good work.

When, however, we consider the amount of work which these boys accomplish, the results are contrary to universal experience. On this point, however, I was not able to get much light—those in charge of the work being very much disposed to accept the results as a matter of course. Unlike the acquiring of the ability to do good work, without regard to the time expended, the manual training schools offer no parallel, since the work of those schools is always done without regard to and, in fact, with an extravagant expenditure of time.

Much of the success is, no doubt, due to the fact that the boys are a picked lot, and that they are under the same pressure to make good that every workman is. Dismissals of those who do not make good, have an effect upon the others which need not be described. The arrangement under which the apprentices are at first in a room by themselves is no doubt another factor. The cost of their work is constantly compared with that from other departments of the works, and they know it. Their awkwardness and ignorance are not subjects of ridicule by their elders, nor are they constantly humiliated by the regular run of practical jokes which pervade all machine shops. Moreover, just as the shop work stimulates interest in the class-room work, so no doubt the classroom work acts to stimulate interest in the shop work.

Whatever the reason may be, and I am far from saying that the above explanation is sufficient, there is a spirit of snap and go about the training rooms that is quite different from the usual listlessness of apprentices.

A Summary of Progress Already Made

As results of the voluminous discussions of recent years we now have in this country examples of four systems of trade teaching: First, the trade school, conducted as part of a manufacturing enterprise; second, the trade school conducted as part of the public system of education; third, the trade school conducted as a private enterprise, and fourth, the coöperative system in which the trade teaching, properly so called, is conducted in a manufacturing establishment, while the class-room work is done in the public schools.

Of these the General Electric Company supplies an admirable example of the first class. That it is a successful enterprise there and that it is not a tax upon the company seems to be demonstrated. The limitation of its usefulness depends upon the fact that in the small works which form such a large percentage of American manufacturing enterprises, its cost would be prohibitive, although it is easy to use this as an excuse and reject the plan for works which are of a size to amply justify its installation.

As a result of the experience at Lynn Mr. Alexander gives it as his opinion that the system may be profitably conducted without being a tax upon the employer in shops employing as few as 500 men, while below that the plan for coöperation in conducting the class-room work as successfully carried on at Bridgeport, Conn., offers a practical way out.

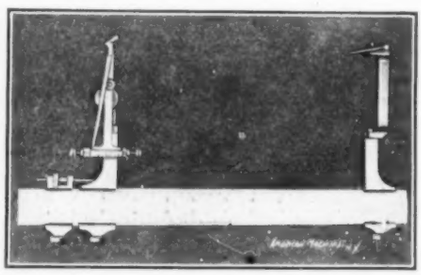
That real progress is being made in connection with industrial education and that we shall soon know the results and the possibilities of the four methods outlined above is clear.

A Composite Measuring Tool

By C. D. Bingham

Having occasion to use a device which would not only indicate but measure the increasing diameter of a cylinder during the process of electroplating and thus ascertain the thickness of the coating, I have united two Starrett tools with some slight additions for such purpose, and the performance of the composite tool has been exceedingly satisfactory in use. The tools thus united are a Starrett micrometer caliper gage No. 24 and universal test indicator No. 64.

The caliper gage consists of a graduated steel scale fitted with slides, one to be set at zero and the other in two parts, one of which may be set at any desired point with the set screw provided and the other part then adjusted by means of a micrometer-head screw. This device will, therefore, caliper and measure any cylinder up to about 3⅞ inches diameter, the legs of these slides being 2 inches long, measured from the lower edge of the scale. But I desired to caliper a cylinder from 8 to 10 inches diameter and further required the contact points to have a considerable degree of elasticity, which was accomplished thus: An extension piece was fitted to the leg of the fixed slide provided with a clamp at its lower extremity to carry a 3-inch length of 3/16-inch drill rod, the object of the latter being to "square" the caliper with the cylinder being measured. The



A Composite Measuring Tool

*Sketch omitted.

leg of the other slide is provided with a shorter extension piece, its lower extremity being flattened into a disk to carry the clamping device of the test indicator.

I found, however, that this clamping device did not hold securely enough for my purpose, and hence clamped upon the leg at the proper place a U-shaped piece to inclose the protractor of the test indicator, provided with set screws abutting upon either end of the protractor with which the entire indicator can be swung upon its center through a small arc. The relative lengths of the extension pieces are such that the contact point of the indicator and the center of the drill rod are the same distance from the edge of the scale when the indicator is at zero.

The tool is thus operated: The stationary slide being set at zero on the scale, the movable slide is placed in contact with it, being then itself at zero. In this position one of the set screws governing the swinging movement of the protractor is slacked off and the other advanced until the indicator point comes to the farthest right-hand division mark on the protractor. I may say that the regular test indicator has the zero mark in the center of the protractor, the point indicating 0.015 on either side of this mark, but for my purpose I regard the right-hand end of the protractor as zero, and thus get a range of 0.030 inch.

If, now, the cylinder to be measured is, say, a little over 8 inches diameter, the movable slide is moved back to the 8-inch division on the scale, the clamping portion being fixed by the set screw. The finer adjustment to bring it exactly to the desired mark may then be had by the micrometer screw. As now set the instrument will both caliper and indicate any distance between 8 and 8.030 inches. Should the diameter exceed the latter figure, the movable slide can be moved further back any desired number of thousandths by the micrometer-head screw, such amount being added to the reading of the indicator point to find the exact diameter. It is true that the diameter thus ascertained is not absolutely accurate, but the error is confined to the slight deviation from a line parallel with the scale of the contact point as it swings on its center. But the error is very small, and is negligible in my use of the tool.

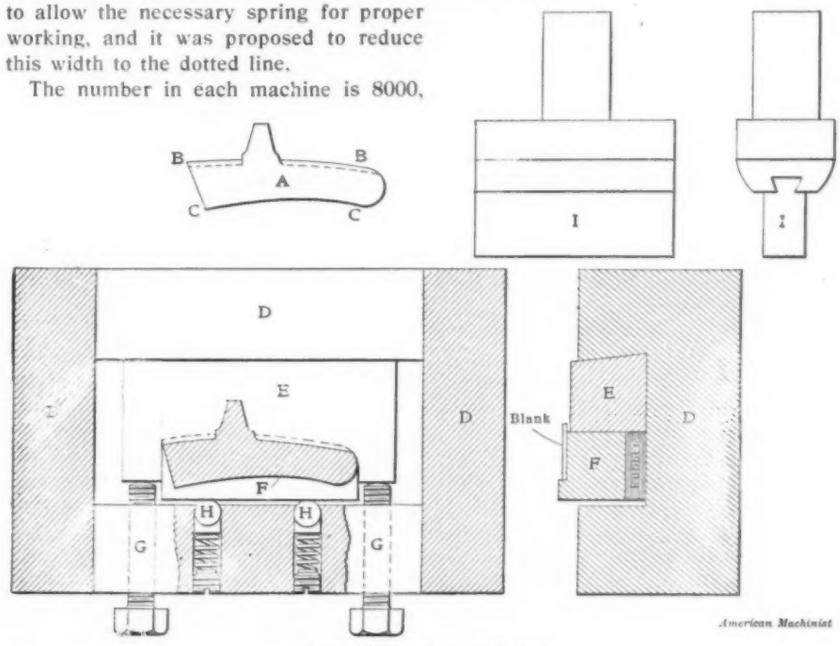
The great advantage of this instrument over a "firm joint," or any fixed caliper is the flexibility afforded by the range of 0.030 inch, which the test indicator provides. With the usual caliper set approximately for its service it either goes over the work or it doesn't, and in either case the amount over or scant is an unknown quantity. Even its setting at the exact diameter of a cylinder is a matter involving the "personal equation," and the diameter can then be only approximately ascertained by afterward measuring the distance between the contact points. These difficulties are largely obviated by the use of the composite instrument above described.

A Trimming Die for Lace Machine Combs

By Jean Jean

A shows what many readers will recognize as a comb of a lace machine. They are made from cold-rolled iron of a special temper and are 0.022 inch thick. Owing to a change of patterns of the lace being made on the machines, it was found that the distance *BC* was too wide to allow the necessary spring for proper working, and it was proposed to reduce this width to the dotted line.

The number in each machine is 8000,



THE WORK AND THE DIE

and having no milling machine I designed the tool shown to trim them in a hand press. *D* is a gray-iron casting; *E*, part of the die with the shape of the tongue worked out female. *F*, the other part of the die, is worked to fit in *E*. Beneath *F* is a piece of rubber to act as a spring. *G G* are two set screws to clamp the die *E*. *H H* are two ½-inch balls, with plates, springs and grub screws to give pressure on *F* against the face of *E* and at the same time to allow a vertical movement of *F*.

The top surface of the punch *F* is machined at the back as a gage for the comb, so that when it is in position to be trimmed it projects to the dotted lines shown on die *E*. *I* is the punch, shaped to the new form of the comb. The lower die *F* is arranged to be 1/32 inch above the shearing die *E*.

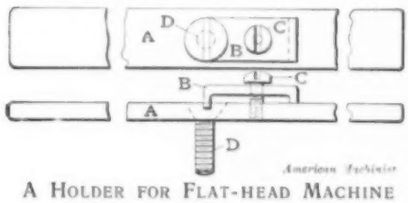
The punch *I* descends, clamps the comb between itself and *F*, and continuing to descend the rubber spring compresses and allows the die *F* to descend below the cutting edge *E*, which trims the comb.

On the return of the ram the die *F* regains its position and the operation is repeated. It proves an excellent and cheap way of doing the job, the trimmed edge being as free from bur and as flat as a new cut blank. We did 16,000 and the tool is good for 160,000 more.

A Holder for Flat Head Machine Screws

By D. H. Smith

The line-cut shows a holder which I use for holding flat-head machine screws



A HOLDER FOR FLAT-HEAD MACHINE SCREWS

while rethreading them. *A* is made of flat cold rolled and can be casehardened if necessary. *B* is made of tool steel and tempered. *C* is an ordinary fillister-head machine screw. *D* is the screw being held.

The PARIS EXHIBITION of AERIAL LOCOMOTION

Monoplanes, Biplanes and Freaks. Also Engines for Airships

BY I. W. CHUBB

The International Exhibition of Aërial Locomotion, held in the Grand Palais, Paris, from September 25 to October 17 last, and organized by the L'Association des Industriels de la Locomotion Aerienne was, as all the world knows, a great success. Most of the interest evoked was due to the display of 26 or more full size heavier-than-air flying machines, the majority of which, though not all, had actually flown. But in addition there were balloons of various types, a few machine tools, a retrospective exhibition, which included the 1903 Wright machine, a couple of motor boats, and a number of accessories and incidentals, the scope being sufficiently wide to include in the galleries not only flying-machine toys, but even billiard boards. Suspended above the ground, the dirigibles almost escaped attention, except by those who took a general rather than a detailed view of the exhibits.

FIG. 1. PARIS AERONAUTICAL EXHIBITION—CENTER OF GRAND PALACE

The views offered in Figs. 1 to 3 include fairly well the whole of the more open part of the exhibition, with which alone the present articles will concern themselves. Fig. 1, illustrating the center of the hall looking from the main entrance, shows the Blériot monoplane, the welcome invader of England, occupying the central position. The machine was, however, on October 14, removed to the National Conservatoire des Arts et Métiers, in Paris, having been presented by the proprietors of the "Matin," who had purchased it from M. Blériot. Ranged round it in "places of honor" were the four stands showing the Wright, Antoinette, R. E. P. and Farman machines, while straight ahead at the back were the Voisin and another Blériot machine, the remainder of the full-sized heavier-than-air machines being placed generally to right and left along the length of the hall.

A word may be said as to the stand decoration. This was of uniform character, chiefly lattice work, painted bluish-gray, while each machine was on a slightly raised platform covered with a bluish carpet. The character of the decoration can be seen in the views mentioned, and also in Fig. 4, which shows the "Avia" monoplane. The exhibition, intended to be international, was, as a matter of fact, entirely French, except as regards one or two English engines.

THE BLERIOT MONOPLANES

Turning to the aëroplanes shown, it will be unnecessary to say much about the Blériot cross-channel flyer. Another Blériot machine, on a second stand, showed the body skeleton, and in particular exhibited the method of steering used. At the lower end of a vertical pillar is a shallow metal bell, to the rim of which the control wires are attached. The pillar has universal joints and is turned by a small steering wheel, placed, of course, in front of the seat. Owing to the bell arrangement, if the pillar as a whole is moved in a cross direction, two control wires can be put in tension at once, and in this way both the elevating action and the warping motion can be adjusted simultaneously. Another Blériot machine, of the No. 12 type, however, has a chain-driven four-blade screw which, it will be remembered, is in front. Special wings for the turning action seem now dispensed with here. As regards the Wright machines on adjoining stands,

except in small details, but little change seems to have been made as compared with earlier models. A Wright biplane was, however, one of the few machines shown designed for a passenger.

The Farman Machine

The Farman machine is generally of the type shown in these columns, heretofore. Winglets are fitted at the backs of the planes. The rudder is twin and is controlled by the feet. The elevator is controlled in conjunction with the side wings by lever. The illustration shows the position of the driver in front of the bottom plane, while tied by two V-frames is the elevator in front, the engine and propeller being at the back. Two skids are employed in alighting, two wheels being carried on top and held in position by rubber strips. As in almost all the machines, these wheels are pneumatic-

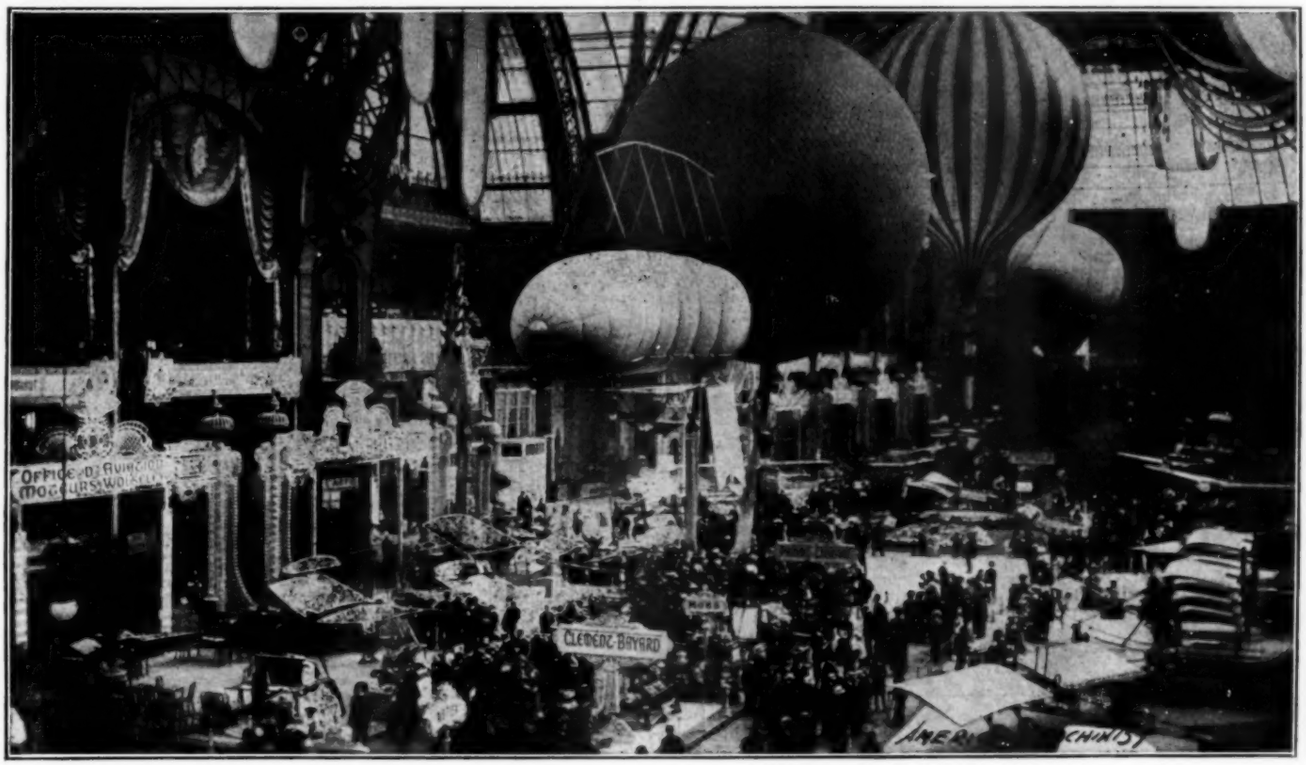


Fig. 2. Paris Aeronautical Exhibition

tired. Two petrol tanks are hung by wires and, like the seat, are adjustable for position to get correct balance. The seating arrangements included space for a passenger behind the aviator.

The Antoinette Models

Of the Antoinette aëroplanes, two models were shown, similar in most respects, except that one had a 16-cylinder, 100-horsepower engine, and the other an 8-cylinder, 50-horsepower engine. The machine, larger than the Blériot, is, of course, well known in Europe, both by reason of its positive success and also by its unsuccessful attempt to cross the English Channel. As, however, the type does not appear to be so well recognized in America, an explanation is offered. The monoplane wings spring from the body with bird-like effect, and the special tail and rudder will be noted. The frame is entirely of wood, and in front the body, of regular boat form, is planked with mahogany, and at the back it is covered with fabric, like the wings. The tubes for the radiator are in two panels along the body. Unlike the photograph, in the newer form the rudder has a vertical fin on top only. Flat tail planes are used. This machine has warping wings controlled by wires. A handwheel on the right controls hight, another on the left transverse stability, and a pedal the direction. Two handles regulate the spark advance and the carburation. The aviator is placed behind the engine, in the frame, just at the back of the wings. The 100-horsepower Antoinette shown was about 49 feet over the tips of the planes, and an overall length of about 40 feet.

The R. E. P. Monoplane

Another of the well known monoplanes was the R.E.P. (Robert Esnault-Pelterie). The whole of the frame was covered with red fabric, and here, unlike the Antoinette machine, the body of the aviator is for the most part above the level of the main planes. Elevator and rudder are controlled by separate levers and the wings can be warped. A 7-cylinder air-cooled, 30 horsepower engine working four on one crank and three on another, drives a four-blade metal tractor in front. The blades shown were almost of rectangular form, riveted to arms of a flattened circular section. Changes have been made in the design to reduce head resistance. Unlike the Antoinette machine, where the wings at the outer extremity rise considerably above the aviator, in the R. E. P. machine they tend downward. The machine now has no horizontal rudder at the back, and vertical motion depends on the angle of the main planes. The steering rudder has been placed above the feathering plane. Wheels are usually placed at the wing tips as well as under the tail and at the front for manœuvering.

The Voisin Machine

The Voisin machine shown was the most recent form. The former front elevation rudder is now removed, its function being performed by the tail. In the old type, as exhibited, a central swiveling vertical plane was employed in the tail. This is now removed and the back box moves up and down, left and right, as a whole. The similarity between this machine and the Farman type will be recognized if it is noted that in the latter the four vertical planes between the two main planes are omitted. In the newer Voisin machine the motor is at the front of the lower plane, whereas in the older Voisin it was on the back of this plane, while again the screw is in front instead of at the back. The control is by means of a steering wheel which can be turned for lateral movement and can be pushed to or from the aviator to regulate elevation. A 50-horsepower Antoinette motor was fitted.

SANTOS DUMONT'S "DEMOISELLE"

Apart from the machines already dealt with, probably the most popular is the "Demoiselle," designed by M. A. Santos-Dumont, to sell at something like £300 ($1500). The designs of this machine were offered freely to the public, although general manufacturing rights are under the control of the firm of Clément-Bayard, of Levallois-Perret. The machine is of the monoplane type with a lifting surface of about 10 meters (108 square feet), the planes having a total spread of about 18 feet, while the full length, front to back, is about 20 feet, the hight to the center of the engine with the machine placed on the ground being about 4 feet 3 inches, and the total hight over the tip of the propeller in its top-most position about 7 feet 6 inches. The total weight has been stated to be less than 250 pounds. The machine is put forward as the smallest, lightest and speediest aëroplane in existence.

The main frame and rudder are of bamboo, which has also been used in building up the planes. To construct the pyramid-form frame, three main 1½-inch bamboo rods are used, two below and one central above, forming a triangle in end view. Brass sockets behind the main plane permit the machine to be dismantled. The struts between are of oval section steel, and in addition there are ties of steel wire, most of them having their own tighteners. The seat for the aviator is simply a canvas sling between the two bottom bamboo rods. The aviator is, therefore, in a very low position. On his right is a lever for elevation, and on the left a wheel for the rudder, while a pedal device controls the cutting in or out of the engine. A feature not exactly new, for it was shown at the English flying-machine exhibition toward the beginning of this year, is the method of controlling the warping of the wings. Behind the seat is a rod which is secured by a strap to the back of the driver. His body motion, therefore, to right or left, regulates the warping action. Connection is not made between the flexing of the wing and the control of the tail.

Before dealing with the latter it may be said that the engine is of the horizontal type with two opposite cylinders placed high above the frame. Clamped to the front end of the top bamboo is a metal piece bearing rectangular sockets, one on each side, for the chief members of the wing frames. On top of the lug is fixed the engine. The two-blade tractor, about 8 feet 6 inches in diameter, is direct driven, of course, in front of the whole machine. The carbureter is under the engine in front of the aviator, and the radiator is in two sections, one on each side of the machine immediately under the full width of the main planes. On the front and back edge of it are comparatively large, square, tin tubes connected with 100 or more tubes of less than ⅛-inch outside diameter.

The engine has cylinders of 130 millimeters (6.2 inches) bore by 120 millimeters (4.8 inches) stroke, and with a total weight of 110 pounds, gives an output at the rate of about 30 horsepower. The water jackets are of copper with electrolytically made joints, and the valves at the cylinder ends are mechanically operated by tappets, cam-controlled, while, as in the Anzani and some other engines, auxiliary ports for the exhaust are drilled through the cylinder. High-tension magneto ignition is employed, driven by bevel gear off the crank shaft. The main planes are built up on two ash spars with bamboo ribs, the full width of the plane being about 6 feet 6 inches, The wing surfaces are formed of silk and the corner stays are of bamboo, the corners themselves being square, not rounded. The tail moves as a whole, and is connected with the frame by a universal joint, the horizontal part of about diamond form with a point cut out, being about 6 feet 6 inches wide by 4 feet 9 inches, and forming an elevator, while the vertical parts are of the same general shape, say 3 feet 7 inches high by 4 feet 9 inches long, and act as a rudder as usual. Both surfaces are flat. To protect the rudder will be seen a metallic vertical tube, with the lower end turned backward and forming a skid. This also guides the elevating-plane wires of the tail. The landing wheels are splayed, as shown, being just in front of the driver. They are carried on a metal tube from the ends of which the wings are stayed

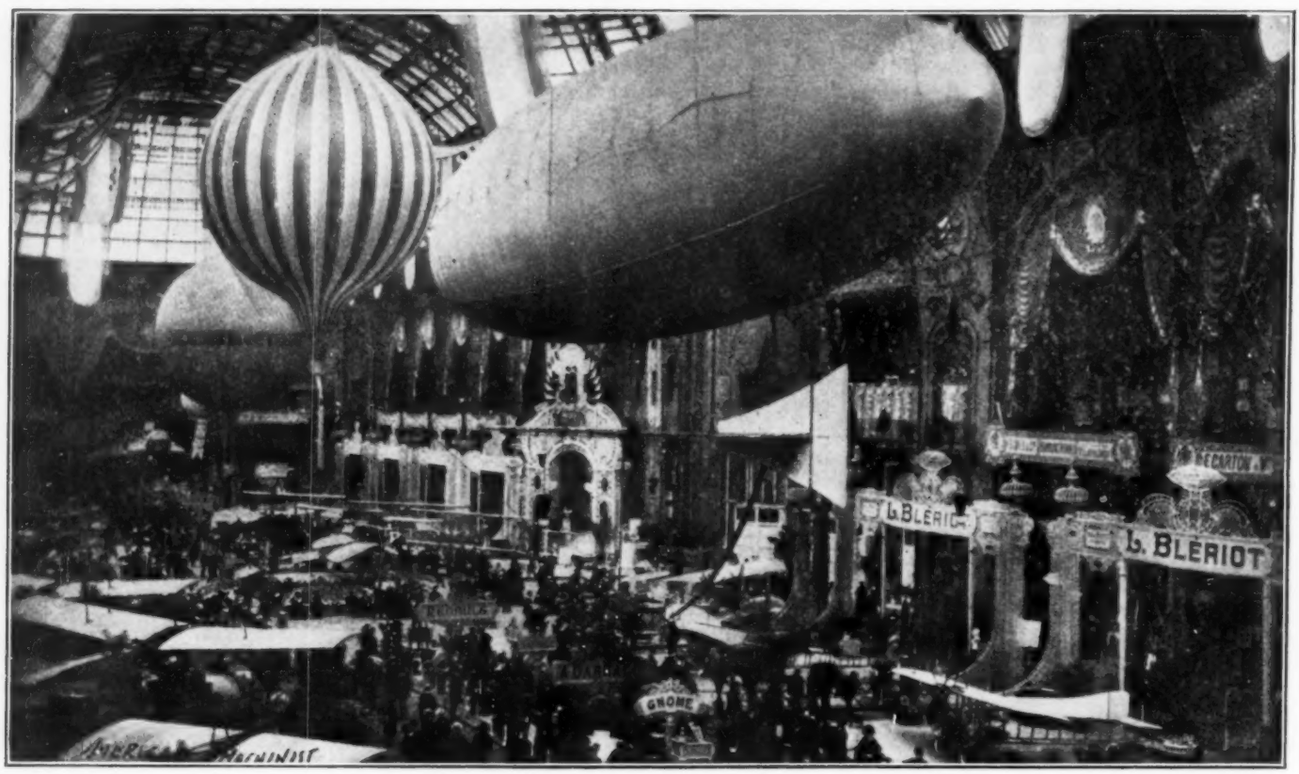


FIG. 3. PARIS AERONAUTICAL EXHIBITION

by wires. Tightening springs are used in the control wires.

The Monoplane "Avia"

The monoplane illustrated in Fig. 4, shown on the stand of Ateliers Vosgiens d'Industrie Aeronautique (itself a shortened title), is, therefore, known as the "Avia." The horizontal tail is fixed much below the main wings and in front of it are twin steering rudders. Some details of construction are given in the illustration. The engine placed on top, is of 20 to 25 horsepower. A tractor screw is used, the chassis with sledge has four wheels, and the driver sits below the main planes, which are warped as usual.

The Gregoire-Gyp Monoplane

A new monoplane of the Blériot type was shown by Grégoire-Gyp, Suresnes, and the diagram, Fig. 5, gives an idea of the design. A feature is found in the differential gear (two wheels and a pinion) connecting the two steel tubes which form the main spars on which the two wings are built. This gear is controlled by a slightly inclined shaft and handwheel, and by this means the two wings are turned in opposite directions, the end of one being depressed, the other raised. The two wings can also, as a whole, be raised or lowered simultaneously by lifting the shaft. The device is obviously intended for security in turning. Another point is that the situation of the wings on the tube can be shifted for balance relatively to the length of the girder-built body, according to whether a passenger is carried or not, two or three positions being available.

The shape of the tail is as illustrated, the triangular rudder being controlled by the swaying of a rest at the back of the aviator. The engine fitted is of four-cylinder, 40-horsepower, with multitubular radiator above the cylinders. The machine measures about 36x36 feet, and the lifting surface is about 22 square meters (say 26 square yards), while the weight has been given as about 660 pounds, of which rather more than 170 pounds is in the engine. A skid is fitted for the protection of the machine, but as exhibited no wheel was shown at the tail end.

The Raoul Vendome Monoplane

The Raoul Vendome monoplane has a double hickory backbone of H-section, bowed somewhat toward the end. At about the center is a V-stay tied to the front and back, and above the frame are two triangular supports for the wings. Perhaps the feature is the use of flaps or hinged tips, one on top and at the end of each main plane. At the outer end each flap is formed with a frame, and its inner end is raised as required by lever-controlled wires. Each flap is of triangular form, secured along the front edge to the fabric of the main plane and kept flat in the downward position by spring, the side that lifts being parallel with the side of the main wing. The object will be readily understood. A curved flexing lifting plane (not pivoted) at the tail forms the extremity of the machine, together with a rudder, roughly of rectangular form, placed under the frame. This rudder is, of course, hinged vertically. In front of it is another vertical plane, not adjustable. The rudder is controlled by pedal, the back elevating plane by lever. At the front the backbone is supported by an inverted U-frame, each leg of which bears a wheel. The engine is of 20 horsepower, and a tractor screw is used. The machine has a spread of about 31 feet by about 35 feet long, and the lifting area is 22 square meters (237 square feet). The weight is about 700 pounds.

The Koechlin Monoplane

The Koechlin machine, also a monoplane, has been generally recognized in its main lines as a combination of the Blériot and Antoinette design, with Voisin landing system. The body is a shell of wood. The diagram, Fig. 6, illustrates the tail, the horizontal plane being flexed. A wheel controls the horizontal motion, and, by movement lengthwise relative to the machine, adjusts the elevation. The wings can be curved automatically by the sidewise movement of the driver from the back of the seat. The engine is of 28 horsepower, and, as in practically all the monoplanes, a tractor screw is used. The frame for engine, etc., is bolted direct to the body front. The wing spread is about 26 ft., and the over-all length about the same, while the lifting area 18 meters (say 21.5 square yards), and the weight complete is about 575 pounds.

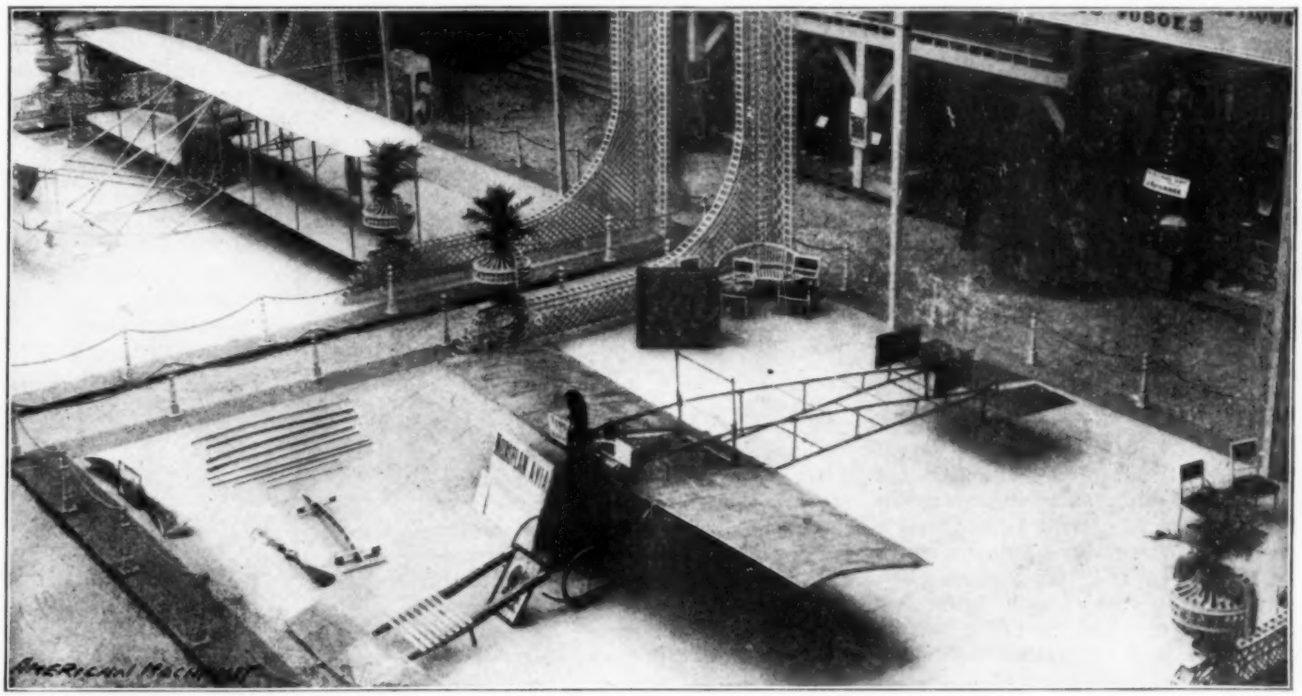


Fig. 4. The Avia Monoplane

The Hanriot and Liore Monoplanes

The Hanriot monoplane with triangular girder chassis is built perhaps otherwise generally on Antoinette lines. The screw, etc., in front is protected by a skid, while at the back the rudder is similarly

guarded. The main planes, however, are almost perfectly horizontal in front view. The spread of the wings is about 31 feet, and the length about the same, while the wing surface is about 24 meters (say 28.5 square yards, the total weight being about 730 pounds. The rudder is controlled by the feet and the warping of the wings and the tail elevation are operated by a lever. For actuating the machine a six-cylinder, 50-horsepower engine is fitted, with two-blade propeller.

The Lioré monoplane has the back portion of each wing hinged so that either extra lift can be obtained or the wing surface can, when necessary, be reduced by one-half. Further, the two back portions can be moved simultaneously, or one at a time. At the tail are two horizontal planes, one fixed to the frame and the other adjustable. The vertical planes above and below are shaped to suit. A lever and universal joint control both

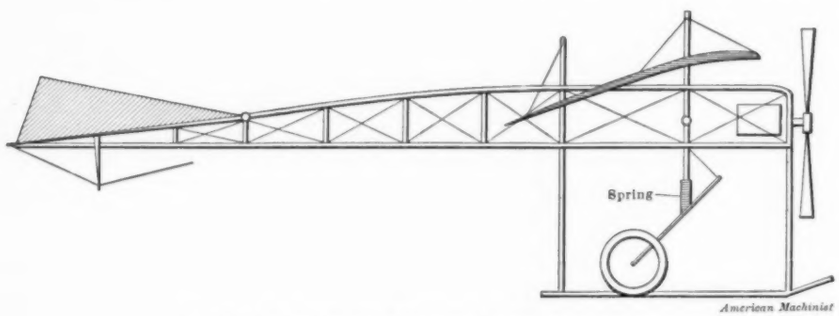


FIG. 5. DIAGRAM OF GREGOIRE-GYP MONOPLANE

elevator and rudder simultaneously, and the rear wheel is so arranged that on landing it can be steered by means of a foot rest. Other features include a clutch to the engine and twin screws. The spread of the wings (nearly horizontal) exceeds 28 feet, and the lifting surface 24 square meters (258 square feet). The engine is a four-cylinder of 35 horsepower, and drives a pair of two-blade tractor screws in opposite directions by means of chains.

The Gangler monoplane was incomplete. A fish-form body is fitted and two curved wings, the twin propeller, chain driven in this case, being behind the planes instead of in front.

BIPLANES

Only three or four biplanes were shown, the most original, perhaps, being that of M. de Penteado, a side view of which is offered in Fig. 7. It will be noted that the engine, five-cylinder, with two-blade wooden tractor screw, is carried in front under the top member of the frame. The top plane, while tending downward at the ends, is almost horizontal, the axis of the screw being well below the top edge of the center of this plane. The two lower planes (one on each side) start in each case well away from the center of the machine, and rise so that the tips join the back half of the top plane. These wings can be flexed and the steering and elevating arrangement will be plain from the diagram. The Chauvière Intégrale screws, in walnut either solid or built up in layers, used in these machines are claimed to be the only form to turn with a periphery speed of even 200 meters (say 650 feet) a second without vibration or deformation. The screws fitted here and on other machines range from 5 feet to 7 feet or so in diameter.

The Duthiel and Chalmers biplane is of the Farman type, with five open cells, and is fitted with the firm's own four-cylinder engine with single two-blade propeller at the back. Midway between the main planes at the ends are two winglets. The elevator is a biplane and the rudder is between two tail planes. A sledge protects the landing wheels. The engine is behind the aviator and is carried on a double ash spring between the cell uprights, and the control is apparently by two handwheels, the spindle of one passing inside that of the other, but the system was not connected up completely.

The Clémont-Bayard biplane, also of Farman type, has winglets between the planes at the back and controlled by pedal. A single-plane front elevator is used, and with vertical rudder and superposed tail planes at the back, is controlled somewhat after the Voisin system. The four-cylinder, 40-horsepower engine carried on the lower plane behind the aviator, drives a wooden screw through gearing which reduces the speed in the ratio of two to one. The machine is large, the sustaining surface having been stated at about 70 square yards, the weight at more than ½ ton.

The Fernandez biplane, Fig. 8, is in a measure a combination of Curtiss and Wright practice. The frame is of steel tubing. A pillar adjusts the single elevating plane in front and carries two cross-pieces, one for the rudder and the other for control of flaps which form back extensions of the main planes. The single chain-driven propeller and eight-cylinder engine of 40 horsepower are placed behind the driver. The frame carries three landing wheels. The spread of the wings is about 28 feet, and the lifting area 25 square meters (29¾ square yards) while the weight of the biplane is about 475 pounds.

As tending toward completion, reference may be made to the biplane built up by J. Rollé on a pedal cycle, but intended in the future to be carried on a motor cycle. The framing is of bamboo and the tail has double elevating planes placed behind the rudder. The main wings are almost flat on under surface, the top plane being about 1½ times the area of the bottom plane. The ends of the top plane too can be flexed. The machine measures about 26x26 feet, the carrying surface about 20 square meters (say 24 square yards), while the total weight was put at about 265 pounds.

AN EIGHT-PLANE MACHINE

Among the curiosities must be mentioned the eight-plane machine by De-Dion-Bouton. In side elevation, however, it recalls the Wright appliance. It is built of steel tubes forming a cube, the lower ends of which are secured to a skid curving to the front and bearing three forward horizontal planes, only two of which, however, can be varied for angle. At the back is a tail plane with twin rudders. In the front elevation will be seen two pairs of inclined arms forming a flat V, and tied to the main frame, as sketched in Fig. 9. The V-frame carries two sets of lifting planes, each of four, with the largest on top and smallest below. Between the pairs are to come two propellers on each side, making four in all,

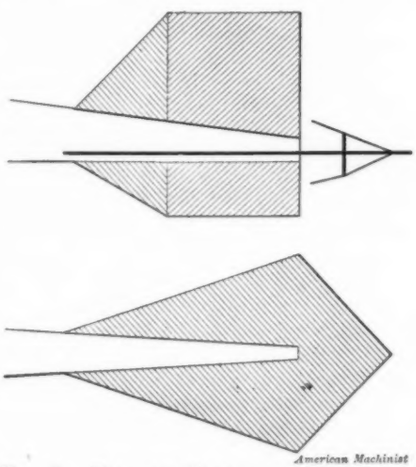


FIG. 6. TAIL OF KOECHLIN MONOPLANE

chain driven from the engine, which, however, was not shown. As the planes are pivoted in position they can be adjusted for lateral stability; also, if necessary, should an accident occur, they can be set for parachute action.

A DOUBLE HELICOPTER

A double helicopter machine, the Vuitton-Huber, was the only one of its type among full-sized apparatus and was not complete, the engine and alighting, etc., system not being in place. For lifting

purposes, two four-bladed screws are employed at the top of the machine and revolve in opposite directions. In construction they are made much on the same lines as ordinary planes, but smaller, of course, being of fabric over a frame. For forward motion a screw at the back is carried on a slightly inclined spindle and is driven off the main vertical shaft.

Perhaps the most extraordinary machine was the eight-plane direct-lifting Salmson appliance. Here, directly under two slightly upward-curving top planes are placed two other planes, which are about semi-circular in end view. They curve downward. Behind the two top planes, in a fore and aft direction, are two other main planes at about the same level and also inclining upward somewhat, while in front is a similar but smaller plane. Lower down in front is a plane projecting to a point. In plan thus the planes present roughly a cross form, one member of the cross, that is, the one at the back, being, however, duplex, while the front member shows a second and tapering plane projecting below it. Then the two side arms are doubled, the top members inclining upward somewhat, while the two lower members bend downward and are about semi-circular in front view. Level with what is considered to be the focus of the latter planes is placed the engine, which drives four propellers in two sets geared together, one set apparently to throw the air against the twin curved planes and thus give a lifting effect, while the other propellers at the back seem to be intended to provide horizontal motion. The whole is carried on a sledge.

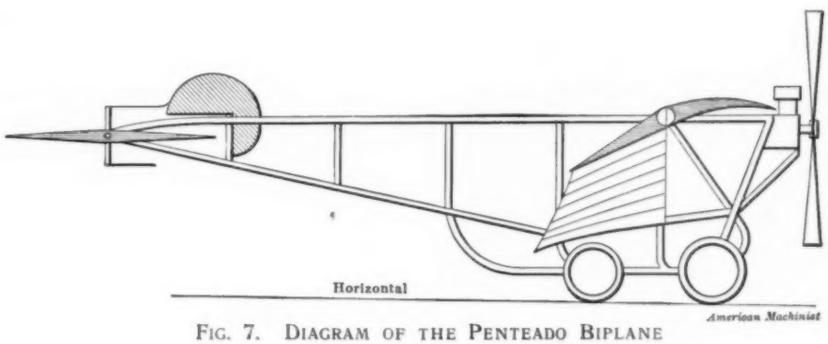


FIG. 7. DIAGRAM OF THE PENTEADO BIPLANE

MACHINES IN GENERAL

It will be plain from the foregoing that the majority of the new machines shown were of the monoplane type. As to whether the planes should be curved or flat there is some measure of difference in practice. Almost without exception, however, they are curved, although the under surface of the Antoinette type is fairly plane. On the other hand, the new Fernandez biplane had a pronounced curve on the under surface, and the Grégoire-Gyp monoplane has a slight curve at the front of the wing and is flat toward the back. In very few cases, however, was the curving specially pronounced. As to water- versus air-cooled engines, I made a list of 21 machines with engines, and of these eight were air-cooled. It has been noted that the wheels on the chassis were nearly all pneumatic-tired, and all had, of course, springs to relieve excessive shocks, and here india rubber was in many instances employed, while in one instance rubber pads were used for the same purpose to hold the propellers, flywheels, of course, being absent.

THE AERONAUTICAL ENGINES

Excepting in two or three examples of a very different character, most of the engines at the Paris Flying Machine Exhibition could fairly be claimed as lineal descendants of the automobile engine. The V-form was fairly common, being used, for instance, by the Renault, Mors, Antoinette, Wolseley, Fiat, E. N. V., Brouhot, and De-Dion-Bouton motors, while the ordinary vertical type was shown by the Clément-Bayard, Pipe, Aster, Buchet, Rougier and other concerns, the fan type by Anzani and the opposed horizontal type by Darracq and Dutheuil Chalmers. As would be expected, lightness was everywhere studied, but generally the engines were on straightforward lines and it was predicted that automobile engines will follow on the same lines.

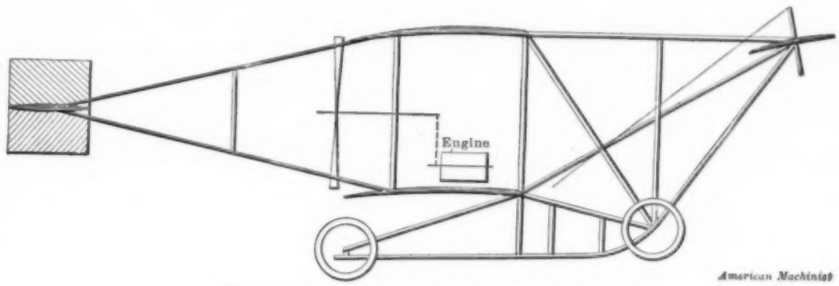


FIG. 8. DIAGRAM OF FERNANDEZ BIPLANE

Perhaps most of the motors had water-cooled cylinders, but in one or two cases, for instance the Renault and the Fiat motors, the engines were inclosed in a sheet-metal case and cooled by a special fan. The V-form is, of course, adopted for its compactness, short shafts, etc., being obtained. Induction and exhaust valves are similarly worked off the same cam shaft. The induction valves were very often automatic. In some cases induction and exhaust valves were concentric, the stem of one valve passing through the other valve, both valves being actuated from one cam. In two or more cases holes were drilled in the cylinder walls for exhaust purposes, access being given by the movement of the piston.

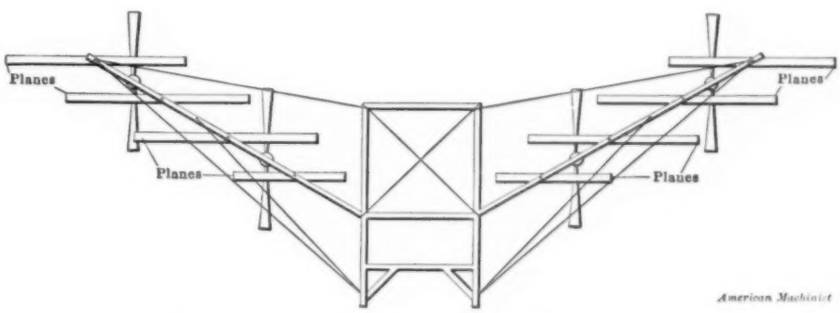


FIG. 9. DIAGRAM OF 8-PLANE DE DION-BOUTON MACHINE

The cylinders in number ranged from 2 to 14 or more, and in size are seldom below 100 millimeters (4 inches) bore by 120 millimeters (4.8 inches) stroke, the other limit being about 140 millimeters (5.6 inches) bore by 160 millimeters (6.4 inches) stroke. The speed was usually above 1000 revolutions a minute, the horsepower usually about 50, varied from 30 to 100 (but a 200-horsepower engine for dirigibles was shown), and apart from special engines, the weight per horsepower ranged from 4 pounds upward.

In one or two instances aluminum is used for the water-jacketing, the Buchet engine, for instance, a six-cylinder motor, having the cylinders cast in pairs, with a rectangular water-cooling frame round the combustion-chamber end, the sides being closed by aluminum sheets held by screws. A Clément-Bayard engine shown had four cylinders cast together, with a copper water jacket surrounding the whole and shaped to the cylinder forms. The pipe arrangement for gas induction and exhaust is somewhat special. All the valves are on one side of the motor. Five openings appear on the valve side, two for induction and three for exhaust. The outer and the two central valves are exhaust, while the four remaining on the engines are for induction and three for exhaust. The outer and the two central valves are exhaust, while the four remaining on the engines are for induction. The arrangement is, of course, symmetrical, reading on either side—exhaust, induction, induction, exhaust, up to the center line. Here, as elsewhere, the pump for water circulation and the magneto are driven off the same shaft. This engine is 40 horsepower, 100 millimeters (4 inches) by 120 millimeters (4.8 inches) the weight being about 220 pounds.

The Eight Cylinder Wolseley Engines

The eight cylinder engine shown by the Wolseley Tool and Motor Company, Ltd., Birmingham, for aëroplane or balloon work, may be taken as an example of the V-type. The cylinders (see Fig. 10) placed 90 degrees apart, are cast in pairs, with heads and liners in one piece. The crankcase is of aluminum. All the valves are inside, and are operated from a central cam shaft by rockers. The carbureter, of the float-feed and spray type, is in the center of the engine over the cam shaft, the idea being to get equal distribution and short induction pipes. The cylinders have water jackets of planished sheet aluminum. The crank shaft is carried in three bearings and the steel connecting rods have phosphor-bronze big ends of white metal. If desired the engine may be arranged to drive from the camshaft at the reduced speed. The weight is 340 pounds complete, including flywheel, magneto, etc., and the power is 50 horsepower at 1350 revolutions, with a maximum of 60 horsepower.

The "Green" Aeronautical Engine

The "Green" motor, manufactured by the Aster Engineering Company, Ltd., Wembly, is an example of one of the most successful vertical engines shown, The engine works on the Otto cycle. The cylinder barrel, turned inside and out, is cast with the crown and valve chambers, in steel. The design gives equal compression spaces in the cylinders. The jacket, merely indicated in the illustrations, is pressed from a single piece of sheet copper and is attached at the lower end by means of the grooved flange at the bottom of the cylinder barrel. The joint is made simply by a rubber ring which, while watertight, allows for movement due to heat.

The openings in the jacket helmet for the valves form metallic washers for the joints. The same is true of the water-pipe joints. The valves are inclosed in cases, as shown, and are interchangeable. They are closed by springs and opened by means of cam-driven rocking levers, which drive tappet pins on the ends of the valve stems, the usual screw-adjusting arrangements being made. The levers are placed in an oiltight casing, divided in halves, and carried by a bracket, which is described as an extension of the washers, held by the locking rings, which secure the jacket to the cylinder head.

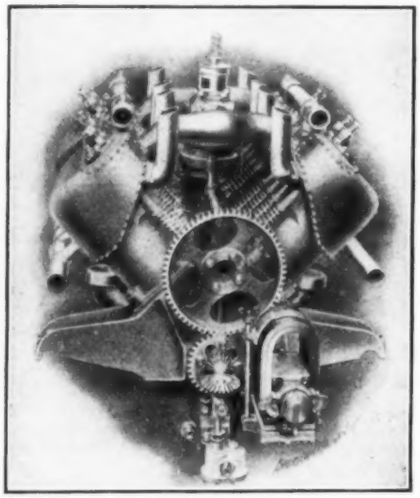


Fig. 10. The Wolseley Aeronautical Engine

The cam shaft is driven by gearing from a vertical spindle, which receives motion from worm wheels off the crank shaft. The valve cages are fastened to the ports by internal locking rings. The ports are also threaded externally, a turned flange taking the copper helmet, which is secured by outer locking rings. The crank case is in two halves divided longitudinally, the upper half being webbed between the crank throws, while cast solid with the walls is a couple of solid columns which are drilled so that bolts can pass to tie together the cylinders and the bearings. In this way any stretch of the aluminum is avoided. The lower half of the chamber is in sheet aluminum, forming an oil pan. The pistons and valve cages are of cast iron, the connecting rods, hollow crank shaft, valves and stems of forged steel, while the flywheel is a steel casting bolted to a flange on the crank shaft. The crank chambers are supported above by six bracket arms. The magneto and water-circulating pumps are in front of the crank case, at right angles to the crank shaft, both being driven by worm gearing. The lubrication system is designed to avoid the use of separate pipes. The main oil channel is cast solid with the crank case the full length of the interior, near the top, oil being forced through it by gear pump through passages at right angles connecting to each of the columns, in which the bolts pass, and thence to the main bearings and crank shaft. These engines are made in two sizes. The 30- to 35-horsepower engine, four cylinders, 105 millimeters (4.2 inches) bore by 120 millimeters (4.8 inches) stroke; the weight 155 pounds with all pipes and carbureter, but without flywheel, which weighs 23½ pounds. The 30-horsepower is developed at 1100 revolutions per minute, and the power can be raised to 45 horsepower for emergency. The 50-60-horsepower, four-cylinder engine is bored, 140 millimeters (5.6 inches) by 146 millimeters (5.8 inches) stroke, the weight being 260 pounds, or with flywheel 37 pounds extra; 50 horsepower is developed at 1050 revolutions a minute. The carbureter weighs 1½ pounds. This type of engine has been used by Moore-Brabazon.

Rotary Engines

Among the rotary engines, first place must be given to the motor by the Société Des Moteurs Gnome, Paris, and used by Farman. It is made in two sizes, namely, 50-horsepower and 100 horsepower. The chief difference is in the number of cylinders, the smaller engines having 7 and the larger 14, of 110 millimeters (4.4 inches) bore by 120 millimeters (4.8 inches) stroke, and running at 1200 revolutions a minute. The smaller engine weighs about 167 pounds, and the larger about 220 pounds, or 2.2 pounds per horsepower. The speed can be varied from 200 to 1300 turns, and the petrol required is from 300 to 350 grams (12½ ounces) per horsepower-hour, and the oil less than 4 pints an hour. The feature of the engine is the use of a hollow stationary crank shaft with revolving cylinders, the driving shaft being connected to the crank case, not the crank shaft. The illustration shows a central circular airtight crank case bearing seven cylinders. The cylinders themselves are turned from the solid, together with the radiating fins, in nickel-steel forgings, the engine obviously being air-cooled. In fact, the whole construction is a triumph for the machinist.

For securing the cylinder, each end passes friction tight through a hole in the crank case, the projecting end being held in place by segments and key. The crank shaft has but a single throw, and to this the chief connecting rod is joined, the big end being disk shape, and bearing pins for the six other connecting rods. Obviously, the pistons can hardly be said to reciprocate; rather they have a movement of rotation eccentric to that of the cylinders. The cams are a series of steel

collars keyed on an axle which can turn round the crank shaft and is driven by gearing inside the crank case. The inlet valves, placed in the pistons, are automatic and counterbalanced, and the gas, like the lubricating oil, passes by suitable pipes through the crank shaft into the combustion chamber. Any ordinary form of carbureter is used. The exhaust valves at the head of the cylinders are cam-actuated by rods and tappet and are counterbalanced. Castings and aluminum are avoided in the construction.

Another rotary motor, the Beck, is at present only in the experimental stage. Its casing consists of two disks, in each of which is half of the circular course in which the pistons work. These are in pairs connected by arms, as illustrated. Between the ends of adjacent arms will be noted rings, four in all, which are fixed in the case and drilled toward each edge with a number of small holes for the admission and exhaust of the mixture, this action being controlled by a cam-driven sleeve or valve inside the distributing rings. Thus either the mixture is admitted, or the exhaust is opened. The outward movement of the pistons caused by the explosion is converted by links or connecting rods into circular motion. It is stated that a motor of 100 horsepower should weigh about 200 pounds. A single cam controls the valves and the ignition. The engine will run at from 90 to 1800 revolutions a minute. To increase the power it is possible to put a number of cylinders side by side on the same shaft.

The Breton motor, also in the experimental stage, and said to give 60 horsepower at 400 revolutions a minute, and to weigh about 200 pounds, is again of the rotary type, with six pairs of cylinders having helical cooling fins arranged round the central case. Each pair of pistons has a common combustion chamber. No carbureter is employed, and the valve stems form plungers for pumping the supply into the combustion chamber. The action of the engine could not be followed clearly in the absence of attendants, but the piston motion seems to be reduced by gearing for the slow speed. Also at the lower end of each cylinder a fan could be seen, apparently to cool the moving parts. All these rotary engines were, of course, air-cooled.

Molding Small Gears on a Machine

By George Buchanan

The molding of small chunky patterns, such as are illustrated, by the bevel and spur pinion, on the machine in Fig. 3, is one of those simple jobs which are certain to lead to trouble and the scrap heap if proper precautions are not taken. These, when chucked in the lathe, are required to run true and when assembled, the teeth must mesh without any chipping or filing, and also without any tendency to stick or jar.

Suitable Flask

Castings of this class do not as a rule mold well in groups of, say, four or more in a flask. My experience along these lines convinces me that perfect tooth gears are only obtained when there is something like an equal distance all-round the pattern for the sand. When this class of pattern is molded in groups it is found that there is more or less movement in the sides of the mold when the metal is being poured, due to one or more of the mold cavities becoming filled before the others, and thereby causing a slight swell or strain, which is only to be detected by the meshing of the gears when assembling. Therefore, we make only two castings at one flask, that is provided with a partition and gives each pattern side support all round. From these flasks, castings without swells are obtained every time.

Making Stripping Plates

When the patterns do not exceed 6 inches in diameter or length it is found to be quite an easy matter to use the patterns to form the openings in the plates. This result is obtained by first molding a blank plate and then fixing the pattern or patterns in the mold in the desired position. The edges of the patterns should be given several coats of plumbago blacking, after they are warmed, so the blacking will dry quickly. It is advisable to heat the pattern, place it in the mold quickly, and cast; so that the plumbago coating and the expansion due to heating the patterns will be sufficient to take care of the contraction on the stripping plate when cooling.

The patterns should be left in the plates until cold and then driven out. After this the stripping plates can be trimmed so the patterns will easily pass through. If the coating has been properly applied, no difficulty will be found in filing the edges, as the plumbago stops the chilling effect that would otherwise take place.

Small patterns of, say, 3 inches diameter, are used in this manner without any trimming being necessary and in many instances a stripping plate is ready for the machine with something like two hours' labor, and without any outside help in the shape of pattern making being required.

Fixing Patterns on Machines

Many methods have been tried when fixing small patterns on stripping-plate machines and the following has been found to be by far the quickest and simplest in actual practice:

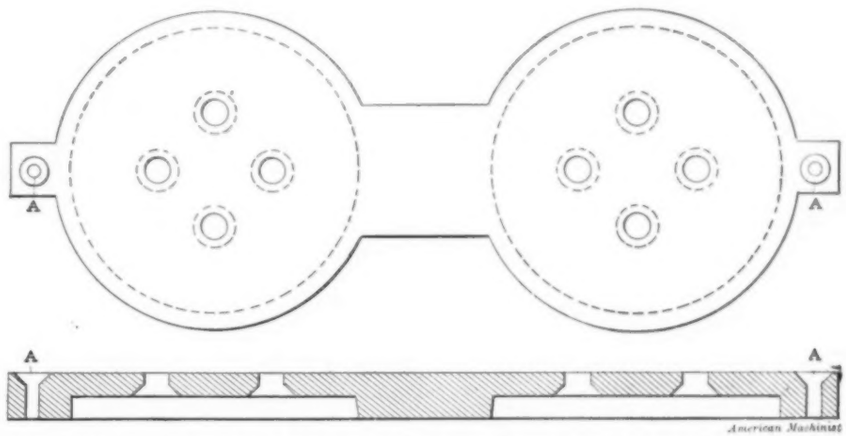


Fig. 1. Pattern Stand for Molding Two Gears in One Flask

The machine is first provided with a pattern stand as shown in Fig. 1. This stand is secured to the pattern carrier of the machine by two screws at *A A*. The stripping plate is next placed on the machine and fastened in place. Fig. 2 is a sectional view of the machine top with the pattern stand and stripping plate in position. The space between the stripper and the stand is filled in with molding sand; a block of wood,

rather smaller than the inside of the pattern, being first placed on the pattern stand through the stripping-plate opening. After the sand has been tucked the wood block is withdrawn and the opening in the stripping plate covered with a core through which the babbitt is run. *B*, Fig. 2, shows the process at this stage and *C*, after the metal has been poured and the gate trimmed off level with the face of the stripping plate. The two patterns are next placed on the machine, their exact positions being secured by dropping the pattern carrier 1/16 inch.

The machine is then placed under a drill and the holes necessary to secure the patterns in their respective positions are drilled and tapped.

Fig. 3 is a sectional view of the machine top with the patterns attached. *D D* are the screws that hold the patterns in place and *E E* are two small holes drilled and pinned from the back of the pattern stand to prevent the pattern from turning when in use.

Locating Top Halves of Patterns

The top halves of the patterns, consisting of the shrouds, are attached to a machined plate. The method used to secure these patterns in their relative positions is, to first place a flask on the machine and ram up the gears. When rammed up, dig a hole to the top of the patterns and take out the two screws *D D*, which hold the patterns in position, then finish the ramming and lift the flask from the machine with the patterns in the mold. Place on the floor and place the shroud patterns on the gears. Next ram up the top flask and lift off; leaving the two shroud patterns in the top flask. The top pattern plate is now located on the flask; two holes having been cast in the plate about 1 inch larger than the pattern dowels. This space is filled with babbitt metal. Fig. 4 shows two views, the top flask with the top plate in position and babbitt run in at *F F*.

The usual plan is to prepare a dozen top plates and pattern stands so that when new patterns are required to be mounted on the machines the only piece that has to be made is the stripping plate. The pattern fitter usually lets us have a new set of patterns mounted one day after receiving the order.

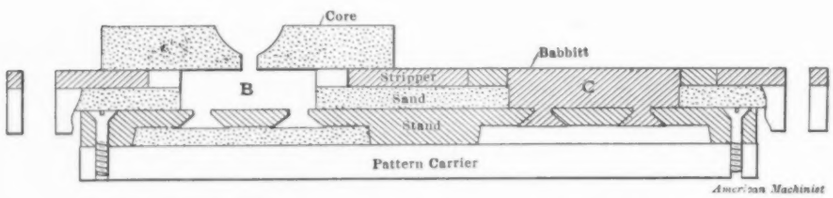


Fig. 2. Method of Fixing Patterns on Machine

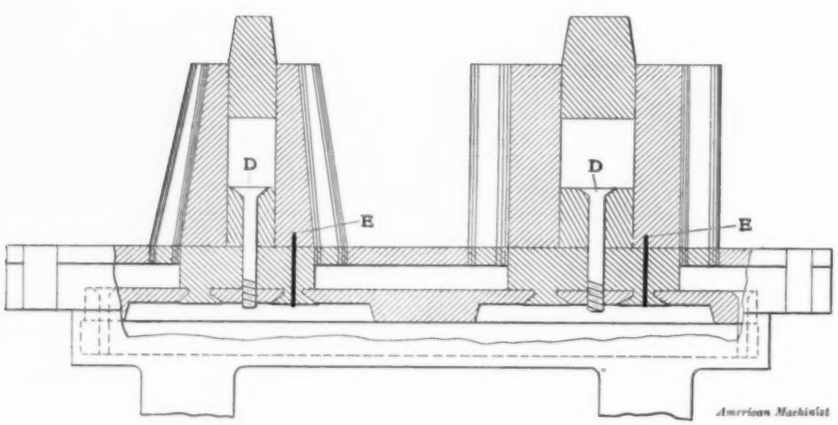


Fig. 3. Machine Top with Patterns Attached

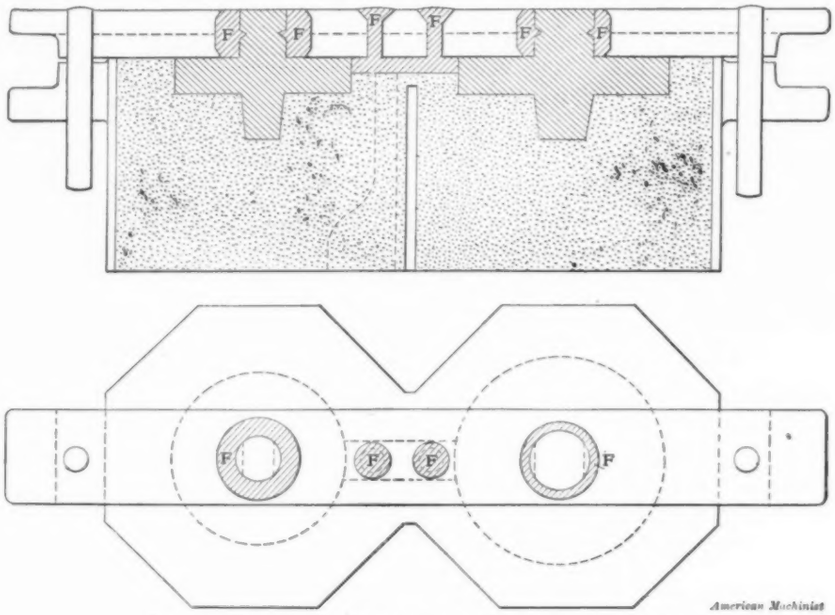


Fig. 4. Top Mold, Shroud of Pattern and Plate

Definition of Alloy

From a paper read before the American Brass Founders' Association it is stated that according to the common understanding, an alloy is a combination or mixture of two or more metals, which, after being brought to a state of fusion and cast, exhibits no objectionable segregation. In distinction between this common interpretation of the word alloy, there is a further distinction or classification, which refers to a combination of two or more metals, which when cast produce an absolutely homogeneous mass, designated by the name—true alloy. A true alloy is one in which the constituents are so merged or dissolved one in the other that they exhibit no structure whatever, one constituent cannot be discerned from the other, they are completely merged. To distinguish such a combination, beside the term true alloy, the term solid solution is also used; such alloys being analogous to compositions of matter, such as glass in which calcium oxide, silica, soda, etc., are so completely dissolved one in the other that an absolutely homogeneous and structureless product is produced.

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STEEL for CUTTERS PUNCHES and DIES

High Chromium Steel Used in France for Casting into Milling Cutters, Punches, Etc.

BY U. C. PERAR

One hears so often about the big shops, their lavish equipment, and what they can do with it in various ways, that it is rather monotonous to men in the small shops; and their name is legion. One of these small shops that is striving after the great things is the firm of Horstman, in the rue St. Maur, Paris, France.

This firm's specialty is the sale of steel, and while they have a small shop and do a fair trade in small tools, they never actually thought of seriously embarking on the uncertain path of their manufacture, until the advent of the steel sold by Darwin & Milner, Sheffield, Eng., under the name of "Durex draw plate steel," that was employed largely for drawing dies for fine wire.

This steel was supplied by this firm to Messrs. Horstman, who realized its possibility to a much greater extent than the makers. The steel has not been employed in Great Britain very much, if at all, on punch and die work; but we have used it in France for that purpose with very good results, and the Horstman firm sell it under the designation of T. C. K.; as such it will be referred to in this article.

Wear of Punches

Personally, while tool superintendent with a large French firm, I was one of the first in that country to use it on punch and die work. We used a lot of Ferracute and Bliss notching presses for arming for 21,480 strokes; then as we got onto the hardening, for 60,000 strokes, and finally, these dies are lasting today for 108,000 strokes of the press.

Another great advantage of the T. C. K. is that it cuts clean, leaving next to no bur, which is essential in the case in point. After the present steel punches have been taken down for grinding, the bur is less than it was with the old steel shortly after the first dozen plates had been punched. The plates' thickness varied from between 1/64 to 1/32 inch.

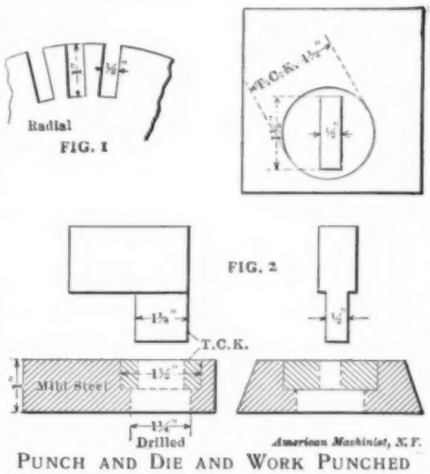


FIG. 1

FIG. 2

PUNCH AND DIE AND WORK PUNCHED

Analysis

An analysis of this steel was made by Monsieur Leon Guillet, with the following results: Carbon, 2.18 per cent.; chromium, 14.88; manganese, 0.71; silicon, 0.19; and phosphorus and sulphur, a trace. Like many other important discoveries, this was the result of a mistake that consisted in the addition of twice as much chromium as was required for the particular steel to be made.

Small Punches and Dies

In Fig. 3 are shown some punches and dies that illustrate the system of making these for notching armature lamination on the Ferracute type of circular notching presses. The piece marked *A*, at the extreme left, shows a round die that was made by drilling out a machinery-steel bolster and heating it up at the same time that the piece with the die hole was heated. This inserted piece of T. C. K. steel was then driven into place while hot and the whole dipped into the animal-oil bath. The punch was made from the T. C. K. steel that was cast in long bars of the desired cross-section.

At *B* and *C* is shown an end and side view of this punch and die, in working position. To the right of the picture is shown another form of the same type of punch and die. At *D* and *E* is shown the side and end view of the two in working position, while *F* and *G* show the die and punch separated.

These die insertions very often develop cracks after being in use, but their only evil effect is to the eye of the toolmaker, as the punchings are not at all affected. These can be made by any shop possessing ordinary equipment; bars of steel of the right cross-section being all that is needed.

Large Punches and Dies

In Fig. 4 is shown a punch and die for producing U-shaped laminations for small transformers, the punch being soft and the die hard. This shows the first attempt at casting punches and dies of the new steel; the work being done in a brass foundry. As will be seen, a crack occurred at *L*, but this in no way interfered with the working of the punch and die, or in the quality of the punching. In this case the T. C. K. steel was not cast into the gray-iron base *K*, which was the method afterward adopted, but it is a snug fit in a recess and steady pinned by pins *H*, etc. *J* is, of course, the injector plate, and *I* are small punche

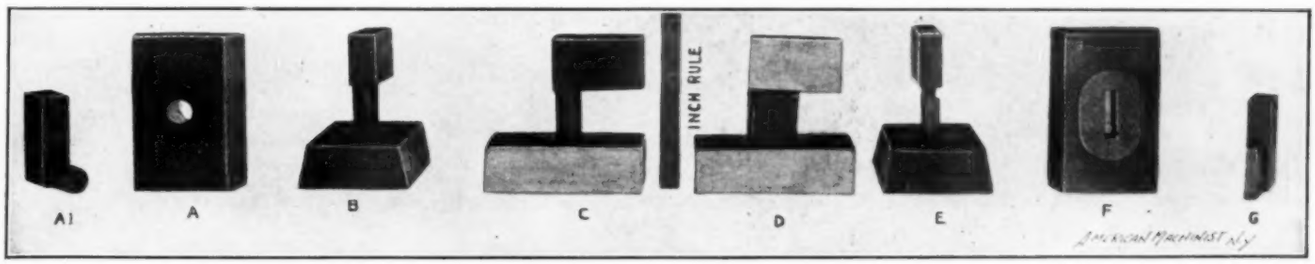


FIG. 3. PUNCHES AND DIES MADE OF T. C. K. STEEL

that were made from T. C. K. steel bars and driven into the base *K*.

In Fig. 5 is shown the later method that was used, of casting the T. C. K. steel in place. In this *M* is the stripper plate in the punch and *N* in the die; *O*, *P* and *Q* being the T. C. K. steel that was cast in place to form the punch and die. In this the punch and die were both made hard.

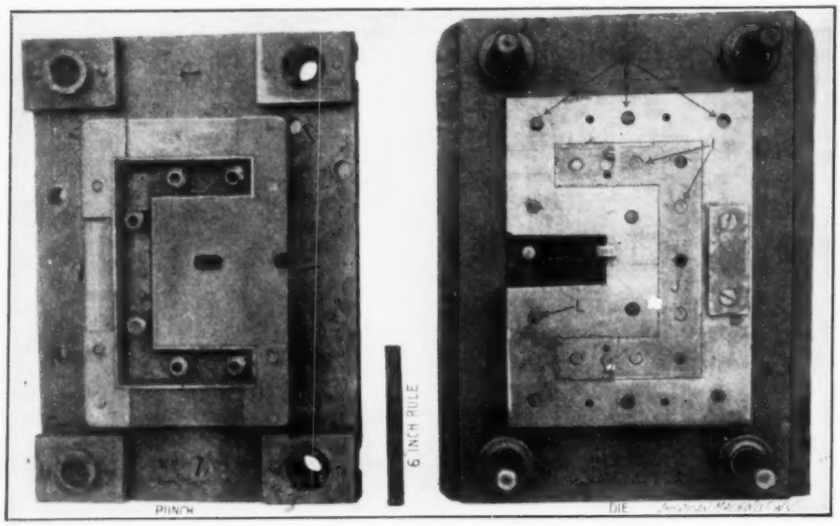


FIG. 4. FIRST LARGE PUNCH AND DIE MADE OF T. C. K. STEEL

GOOD POINTS ABOUT THE STEEL

The advantages of T. C. K. steel are numerous, and it is worth anyone's while to take it up and experiment with it, be his shop large or small.

It can be cast into any form desired in any ordinary brass foundry, but to go into it seriously a first-class foundry equipped with heat-measuring instruments is needed; also an intelligent and enthusiastic foundry foreman. It does

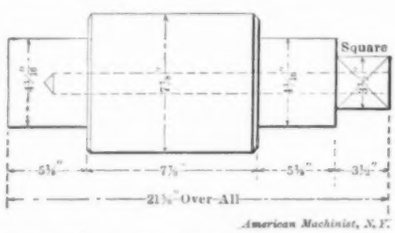


FIG. 6. A SPECIMEN HARDENED AND GROUND ROLL

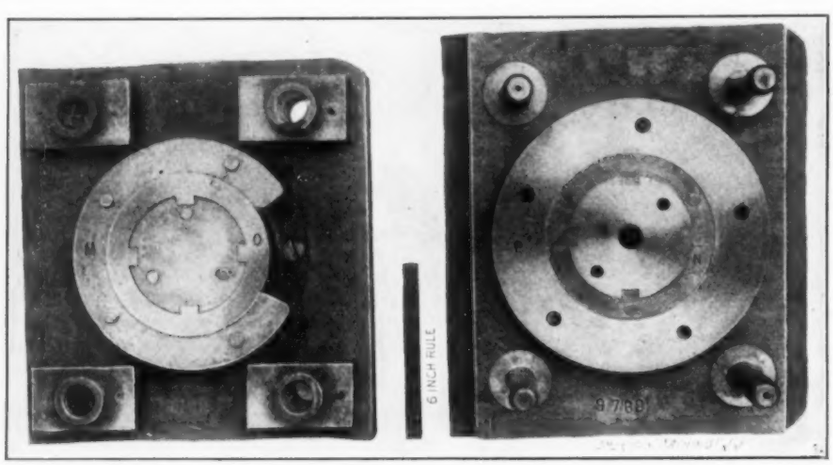


FIG. 5. PUNCH AND DIE STEEL CAST IN PLACE IN GRAY-IRON BASE

not shrink at all in hardening, which makes it very valuable for die work.

On milling cutters, especially gear cutters much better results can be obtained as regards finish, etc., than on any other steel I have ever seen. For taps, especially master taps, or master plates, of any kind, it is a very fine steel to use, and on large laps it would doubtless be economical to cast the flutes in place; then anneal, thread and harden them.

CASTINGS

The roll, shown in Fig. 5, was made of it and gave splendid results, as the hardening extended right through to the center. The weight of this roll was 215 pounds and 0.004 inch was left for grinding after hardening; absolutely no deformation ensued.

Personally I have cast the die for producing the laminations of the pole piece, shown diagramatically in Fig. 7, and have cast others of the nature, shown in Fig. 5, this being a segment for a big machine. The die for Fig. 7 was not cast into the base but in one solid piece. Ordinarily, for a die of this size it would not pay to cast, but this one was in a hurry and was an experiment only. Therefore, advantage was taken of the fact that it could be made of this steel quickly and easily.

RULES FOR CASTING

The shrinkage difference between T. C. K. castings and the pattern is about 0.14 per cent., while cast iron is about 1 per cent. The metal can be melted in an ordinary brass crucible, but, of course, it is preferable to use one of the several types on the market. The molten steel is very fluid and consequently pours readily.

Cuttings and waste pieces should be carefully kept and handed into the store room to be sorted and afterward passed to the foundry, where they should be verified again. The spark test can be used to advantage where there is any doubt.

In Fig. 9 is shown a standard round die for producing armature lamination. In this a cast-iron disk was made and the T. C. K. steel cast in it. The first two or three trials were dead failures, but

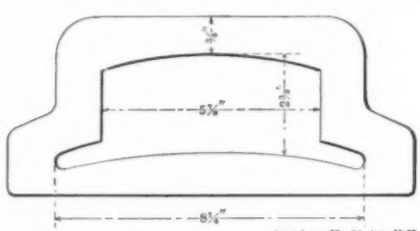


FIG. 7. STEEL CASTING FOR DIE

eventually the brass-foundry foreman, who was fortunately an enthusiast, rigged up some stunts and had the cast-iron bases as hot as possible before the T. C. K. steel was run in. This system means that a round die never goes into the tool fitter's or turner's hands without being absolutely finished at the planer and the special grinder for such dies.

DIFFICULTIES TO OVERCOME

The English firm, I believe, now supplies this steel only to Messrs. Horstman, and they have spent nearly $20,000 on experiments with it. It is very friable, and when used for such heavy duty as press work, it must be reinforced. This reinforcement, as used for punches and dies of the class shown in Figs. 2 and 3, may be done by inserting the T. C. K. steel in a mild-steel base, when both are heated to about 1650 degrees Fahrenheit, the hardening temperature. The two are then plunged into some animal oil and the shrinking and hardening takes place simultaneously.

Like any other steel, but in this case

even more so, the metal has to be handled by a man who has carefully kept records and works by these. It is of no use to try and get all the good there is to be got from this steel if the hardening room and foundry are not equipped with pyrometers; and unless some one man makes it his especial duty to follow up every failure and reason out the why and wherefore of it. If records are kept of these, they can be used in the form of process specifications.

This new steel cannot be forced; that is, as compared with other tool steels,

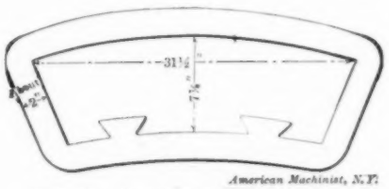


FIG. 8. SEGMENT-DIE CASTING

but for bars, flats and rounds, in the smaller sizes, forging, that is, hammering, improves the steel and tends to eliminate the center shrink holes which occur when casting. As it can be cast into any form required, however, many consider this a great advantage.

CAST CUTTERS

In Fig. 10 are shown several cutters I have personally had cast. The thickness of about 3/16 inch is a limit, or was for our foundry, and even then great care had to be exercised and the molds placed in a hot furnace and the whole allowed to cool down slowly.

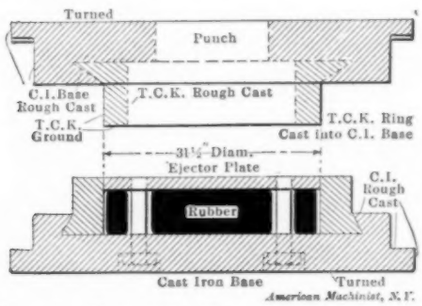


FIG. 9. CAST-IRON BOX WITH T. C. K. STEEL CAST INSIDE

When T. C. K. steel comes from the foundry it is exceedingly hard, and has to be annealed. In this case of dies that are cast solid in cast iron, the mold is allowed to cool down in two or three days and then no further annealing is necessary or possible.

The beauty of casting cutters is, that if an expensive milling cutter breaks and the shape will permit its being used as a pattern, all one has to do is to order "one off in T. C. K," and in 24 hours or so a new cutter is at work. Cutters *B* and *C* in Fig. 10 were cast from broken cutters in this way. They were cast with an allowance of 1/64 inch on each side for truing up, and were then entirely

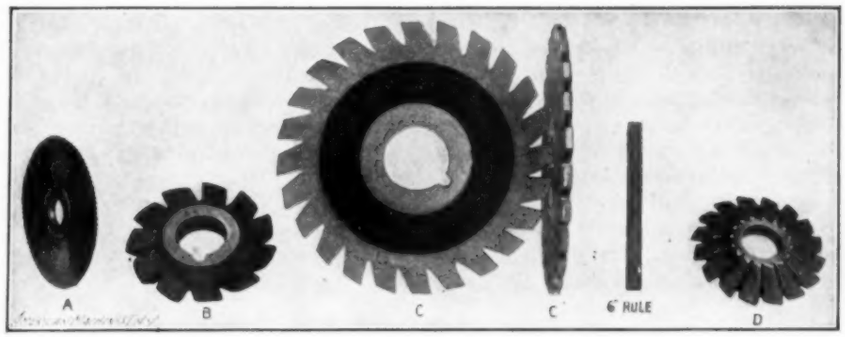


FIG. 10. SOME CUTTERS CAST

finished on a grinding machine with a face attachment; the keyway being finished with the internal-grinding fixture. I have backed off a special cutter by mounting the internal-grinding attach-

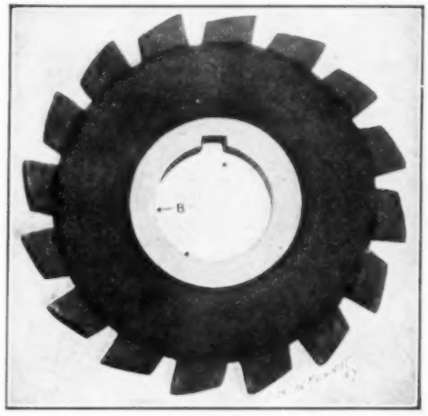


FIG. 11. CUTTER AS CAST, AFTER GRINDING THE HUB

ment from a grinder on the tool post of a Pratt & Whitney relieving lathe.

SAWS AND PRINTING DIES

Cutter *C* is a slitting saw which was used for the armature-milling operations, and cutter *B* is cast from a cutter that was marked heavily on the original. This

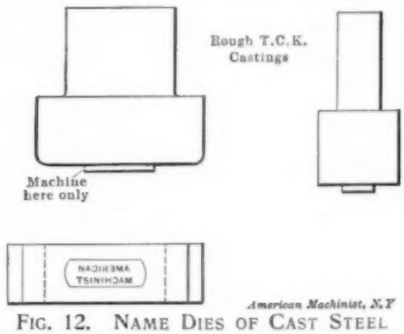


FIG. 12. NAME DIES OF CAST STEEL

marking is plainly visible on the face of the castings and gives a good idea of the steel's fluidity when melted.

Cutter *A* is a copper saw about 1/16 inch thick that was made from the cast bar. It is possible to make cutters of almost any thickness and diameter in this way. Cutter *D* is the same cutter that is shown in Fig. 7.

A noteworthy application of T. C. K. steel that shows its ability to resist pressure, where there is no shock, is in the printing dies for naming reamers, twist drills, etc., one of which is shown in Fig. 12. These are cast in the shape shown, and the face is then ground after being annealed, and a blank is passed to the toolmaker who engraves the dies.

HEAT TREATMENT

A general rule when casting such pieces as are shown in Fig. 6 is that after they are annealed, turned and hardened, reheat them to a temperature of about 850 degrees Fahrenheit and lower without drawing the temper. Such treatment greatly minimizes the chance of breakage.

Where the steel is reinforced, even if a fissure or two do occur, it makes no difference to the quality of the work produced; therefore, in this instance, the reheating and drawing can be omitted. It should, however, always be done for

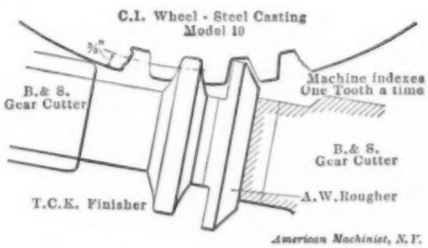

C.I. Wheel - Steel Casting Model 10
B.& S. Gear Cutter
Machine Indexes One Tooth a time
B.& S. Gear Cutter
T.C.K. Finisher
A.W. Rougher
American Machinist, N.Y.

FIG. 13. CAST CUTTERS FOR GEAR WHEELS

unsupported punches, especially of the type shown in Figs. 2 and 3.

To harden it heat slowly in an open fire, or preferably a muffled furnace to from 1750 to 1850 degrees Fahrenheit, draw from the furnace quickly and hold in the atmosphere for about 15 seconds, and when a clear red plunge into an animal-oil bath of sufficient capacity to assure of complete cooling.

When annealing, heat to 1600 degrees Fahrenheit, and keep the temperature absolutely constant for a minimum of two hours; then allow the furnace and steel to cool down together as slowly as possible. For the annealing of large pieces and the cooling down of insertion

castings I have used homemade furnaces that gave very good results.

The best results in hardening are obtained with the electric furnace, but in default of this a coke or coal-fired furnace, or even a simple forge fire can be used. A gas furnace without a muffle must never be employed.

For cutters or other tools that are to work on cast iron, it is well to heat the tools up to 1900 degrees Fahrenheit before cooling in the oil bath and then to reheat.

Before grinding such cutters as are shown in Fig. 10 they should be let down in an oil bath similar to that which is done for carbonized and case-hardened material, the amount of letting down, of course, varying with the size of the tool and the work it has to do. The object of this is to secure the maximum of hardness consistent with a certain amount of resistance.

Gear Cutters

Perhaps the most successful experience with this steel was in the application to cutters for gear wheels of module 10. These were for railway motors and were of steel castings. No end of trouble was experienced in getting a clean-finished tooth until a pair of cutters were mounted on a Brown & Sharpe gear cutter No. 5; the finisher being in T. C. K. steel and the rougher in A. W. steel. With this application the cutters were taken down for grinding once, where the single A. W. cutter was taken down four times. The rate of production was increased 70 per cent., and a better job was produced. These cutters are shown diagrammatically in Fig. 13.

If it were possible to cast under pressure the smaller pieces that tend to leave holes in the center on cooling, doubtless the use for this steel would be even wider than it is at present.

This steel is sold in bars, in Paris, at about 50 cents per pound.

The Hatchet Planimeter

By H. R. Edgecomb

In its simplest form the hatchet or "stang" planimeter consists of a heavy wire with both ends bent down to form legs of equal length, one of which is pointed, the other flattened to a hatchet-like blade. A two-bladed penknife with one blade wide open and the other half open serves for areas within its range. To be accurate the blade must be in a line passing through the point.

London *Engineering*, May, 25, 1894, after publishing a description of the instrument makes this comment: "This explanation has been written not because the instrument is of importance but because the geometry of the problem is interesting and because vague and erroneous statements have been promulgated regarding its accuracy." It is true that this instrument is one that almost does its work right and at the time the article referred to was written it was necessary to make tedious calculations to correct its errors. Various improvements have been made since that time, principally by Prof. John Goodman, of Leeds, England, which remove this difficulty and make the hatchet as reliable as it is simple.

Fig. 1 shows the simplest form as well as a number of minor variations the advantages of which are presumably self-evident. The more important improvements will be described at length later.

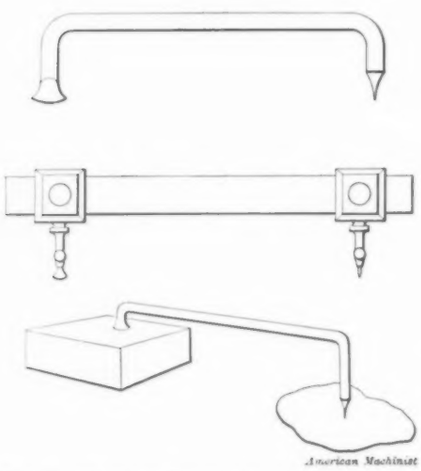


Fig. 1. Simple Forms of the Hatchet Planimeter

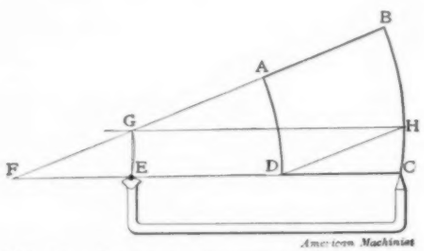


Fig. 2. Diagram Illustrating Theory of the Hatchet Planimeter

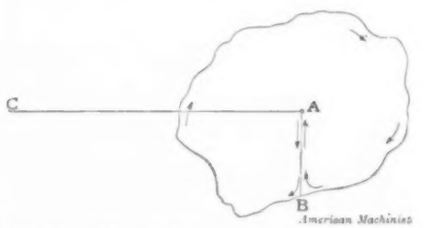


Fig. 3. Use of Approximate Center of Gravity with Hatchet Planimeter

Theory of Hatchet Planimeter

The theory of this planimeter may be demonstrated as follows: In Fig. 2, *A B C D* is an area to be measured; *A B* and *C D* are radial from *F*; *B C* is an arc with its center at *G*. Placing the point of the planimeter at *C* and the blade at *E* the point is moved around the perimeter *C D A B C*. The blade, if allowed to move freely, will pass first to *F*, pivot on *F*, then move to *G* and pivot on *G*. During the trip of the point around the figure the blade has gained an altitude measured by *G E*, and this hight multiplied by the length of beam *C E* gives the area of the figure *A B C D* less the area represented by the triangle *G F E*. This is proved thus: Triangle *B F C* minus *A B C D* equals triangle *A F D*; but *A F D* and *B G H* are equal and triangle *B F C* minus triangle *E G H* equals *G H C F* which is, therefore, equal to *A B C D*. Now *G E* times *C E* is the area of the parallelogram *G H C E* which, when area *G F E* is added, equals the area to be measured. This shortage in measurement is the characteristic error of the instrument.

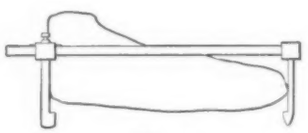
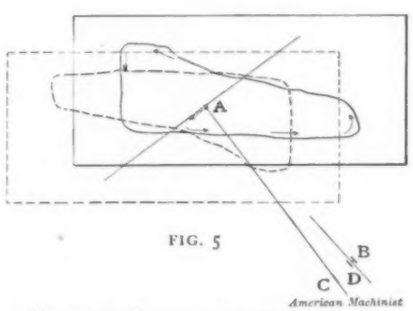


Fig. 4



Hatchet Planimeter Used on an Indicator Card

In practical use this planimeter is used as follows: Referring to Fig. 3, an approximate center of gravity is chosen at *A* and a line *A B* drawn to the perimeter. At right angles to *A B* a line *A C* is drawn and on this line the instrument is

placed with point at *A* and blade on line *A C*. The point is made to travel from *A* to *B*, then around the perimeter of the figure and back to *A* as shown by arrows. A slight pressure upon the blade before starting and after completing the circuit registers by two dents in the paper the altitude referred to as *G E* in the preceding geometrical demonstration. When this altitude is multiplied by the length of beam the result is the area desired minus the constant of error. Professor Goodman found by experiment that if line *A C* were at right angles with *A B* the shortage would be approximately 2½ per cent. of the area to be measured. He therefore made one of the legs of his instrument to slide so that adjustments in length of beam might be made. This arrangement, Fig. 4, was also particularly useful in the measurement of indicator cards, for when the legs are placed as far apart as the length of the diagram plus 2½ per cent., the hight determined is the mean hight of the card.

Inaccuracies in Selecting Center of Gravity

At this point it might be well to look into the inaccuracies resulting from selecting an approximate center of gravity and to show how these irregularities are overcome. Referring to Fig. 5, point *A* is selected as the approximate center of gravity and, the circuit having been made once, the hatchet takes its position at *C*, its starting position being at *B*. Holding the planimeter carefully in this position we revolve the card through 180 degrees, using the point of the planimeter as a center. If the circuit of the figure is now made, moving the

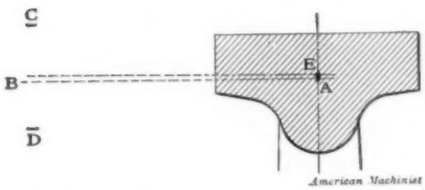


Fig. 6. Averaging Hight of Approximate Rectangle for Rim Section of a Gear

point in the opposite direction, the hatchet blade will probably not coincide with *B* but will be slightly above or below as at *D*. The altitude measurement is thus taken as the distance from *C* to the mean between *E* and *D*. It is obvious that the same thing can be accomplished by turning the instrument instead of the figure through 180 degrees. For still further accuracy it is suggested that the area be measured in four positions, 90 degrees apart, and the average of these measurements taken. If a line containing the center of gravity is given the process is simplified. Fig. 6 shows this type of figure which is very common in machine design. In this case it is only necessary to select a point in this center line and, placing the planimeter at right angles to center line trace the figure first in one direction and then in the other, taking a mean of the two hights, *B C* and *B D*.

The true center of gravity in the last case is found by projecting this mean point over to the center line. At *A* is the approximate center of gravity and *E* the exact center. If the figure is entirely irregular as in Fig. 7, a double reading is taken at each of the four positions shown, and the opposite mean points are connected. These connecting lines intersect at the center of gravity. It is necessary that the lines passing through the approximate center of gravity be at right angles.

Improvements in the Instrument

The most important improvement in this instrument is the provision of a scale forming part of the beam from which direct readings for areas may be taken, Fig. 8; this arrangement was

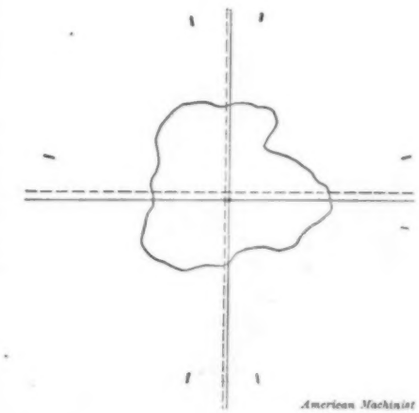


Fig. 7. Averaging for an Irregular Figure with Hatchet Planimeter

patented by Professor Goodman in 1893. He found that if the radius of the curved scale were made equal to the length of the beam, divisions equally spaced might be placed on the scale which would read area direct. This provision increases the range and insures more accurate measurements.

It is evident that a slight tipping to either side with resulting inaccuracy is unavoidable and to correct this I have made an instrument with two supporting feet placed as near as possible to the tracing point, Fig. 9. The tracing point is raised a very small amount from the paper and the wheel is held absolutely vertical. It should be said parenthetically that the drawing board or table on which the measurements are taken should always be as nearly level as possible.

In the instrument shown in Fig. 9, the pointer was made laterally adjustable so that after repeated tests on variously shaped figures the correct allowance could be made. The length of beam was 10 inches plus the allowance when the pointer was properly set and readings were taken by revolving in alternate directions as shown in Fig. 6, the measurement between dents *C* and *D* was taken with a scale reading in fiftieths. Each fiftieth indicated directly one-tenth of a square inch.

Its simplicity and consequent cheapness of manufacture makes the hatchet planimeter a desirable instrument for general use as it is within six-tenths of

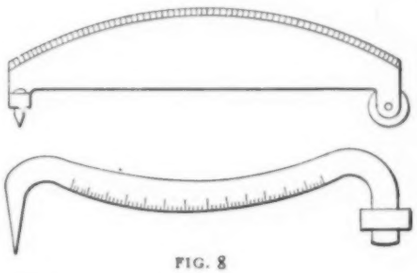


Fig. 8

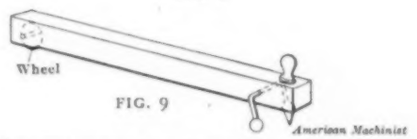


Fig. 9

Modification and Improvements of the Hatchet Planimeter

one per cent. as accurate as the Amsler planimeter which is recognized as standard. So far as I know it is not manufactured or sold in this country, at least not by any of the larger instrument makers.

Operation of British Patent Act

From a consular report it is noted that the first year's working of the British patents act has resulted in the introduction into the United Kingdom of $2,500,000 foreign capital. The value of the land and premises acquired by foreign firms who have decided to carry on their manufactures in Great Britain in order to maintain patent rights is estimated at $635,000. The expenditure for buildings was $880,000; plant and machinery, $895,000, making a total of $2,410,000. In addition, it is stated that a great many firms have arranged for English factories to manufacture their patented articles on a royalty basis.

The consul making the report is of the opinion that the results of the act have come up to expectations and believes its beneficial effect to England will continually increase.

WOODEN CYLINDERS on an OLD BLOWER

Last of Its Kind in New England, to Supply Blast for Making Charcoal Iron

BY E. A. DIXIE

The first discovery of iron ore in this country took place in North Carolina, but the first successful iron works was established at Massachusetts bay in 1632.

In 1637 the General Court of Massachusetts granted to Abraham Shaw one-half of the benefits of any "Coles or yron stone wch shal be found in any comon ground wch is in the countryes disposeing."

The first casting, an iron pot of about a quart capacity, was made at Lynn, Mass., about 1645 by a certain Joseph Jenks. This pot is still in existence. Jenks, later made the dies for the silver coins which were struck at the Boston mint and had on one side of them a pine tree.

With the years the iron industry spread throughout New England wherever extensive deposits of good iron ore were found.

Two such orebeds occur at Kent and Salisbury, both in Litchfield county, Conn., while limestone for flux is also found in large quantities and hard wood for charcoal can be had in abundance or rather could be had in the early days.

A bloomery forge was started by Thomas Lamb at Lime Rock, Litchfield county, Conn., in 1734, which produced from 500 to 700 pounds of iron per day. A blast furnace was added later and ran for many years. Salisbury ore was used exclusively at this plant, about 3 tons of ore and 250 bushels of charcoal being required to produce a ton of iron.

At the close of the 18th century, Litchfield county had 50 bloomery forges, for making iron direct from the ore, and 3 slitting mills.

FIG. 1. GENERAL VIEW OF THE KENT FURNACE, WITH POWER HOUSE IN THE FOREGROUND

Kent furnace, a general view of which is shown in Fig. 1, is situated near the Housatonic river about a mile above Kent, Conn. The furnace is the third one which has occupied this site, the previous ones having been destroyed.

The building in the foreground in Fig. 1 is the power house and contains two water wheels—a large one for driving the wooden pistons of the wooden air pumps for the blast, and a small one for pumping the cooling water used in the tuyeres, etc. This water was drawn from the tail race. The power house is very dilapidated as can be seen in Fig. 2, which is an internal view, looking from right to left in Fig. 1. Here and there the beams, 12 inches square, are rotted to the consistency of punk, while others are apparently as sound as when they were put in years ago.

The wheel, of the undershot type, is 16 feet in diameter 11-foot face, and the buckets are spaced 12 inches on the rim. The shaft is of iron, octagonal in section and 8½ inches across the flats. The spiders are wedged to the shaft, which they fit loosely.

There is no cap for either of the bearings, the weight of the wheel being depended upon to keep it in place.

The crank webs are of cast iron keyed to the shaft and have wrought-iron crank pins keyed in.

The connecting rods are of oak 5 inches wide by 10 inches deep in the center of their length, which is 16 feet. They taper at the ends and are provided at both the crank pin and crosshead ends with cast-iron boxes retained by wrought-iron straps with gib and cotter adjustment, see *B*, Fig. 2.

The small water wheel, the rim of which shows at *A*, Fig. 2, is about 5 feet in diameter by 5-foot face and drives, through a wooden beam, a 3-inch cast-iron ram pump about 12-inch stroke. This supplies the cooling water for the tuyeres, etc.

Fig. 3 shows a general view of the blower room, which is the right-hand

end of the building shown in the foreground in Fig. 1.

Fig. 4 shows one of the wooden blowing cylinders. There are two of these, 50 inches in diameter by 60-inch stroke. The crosshead is of cast iron working on cast-iron guides secured to wooden beams.

The crosshead slippers are made up of sheet iron and wood, probably apple wood as this was a favorite and good material for this purpose in the old days. Even as late as the Centennial Exhibition in Philadelphia in 1876, one of the prize steam engines there had applewood guides.

Each piston rod runs through a hole in the back cover and extends as a tail rod, sliding in a half-round groove in a long timber at the back of each cylinder.

Air was admitted to the cylinders at each end (they are double-acting) through the clack or flap valve *A*, Figs. 3 and 4. These valves are of wood, hung on leather hinges, and have a piece of leather, tacked around the edge of the face which comes in contact with the cylinder head, to act as packing. The eduction pipe *B*, of tin is 13 inches in diameter and leads into the box *C*, Fig. 4, and from there the air passes into the bottom of the wooden accumulator *D*, which is merely a cylindrical wooden tub open at the top, 66 inches in diameter by 60 inches high, with walls 4 inches thick. The piston is packed with leather and in the center of it is the square wooden guide rod *E*, made of above. The bottom of the guide rod is 5-inch oak and working in a guide fastened to the center of the piston by four angle irons and by four iron struts which spread about a foot where they join the piston.

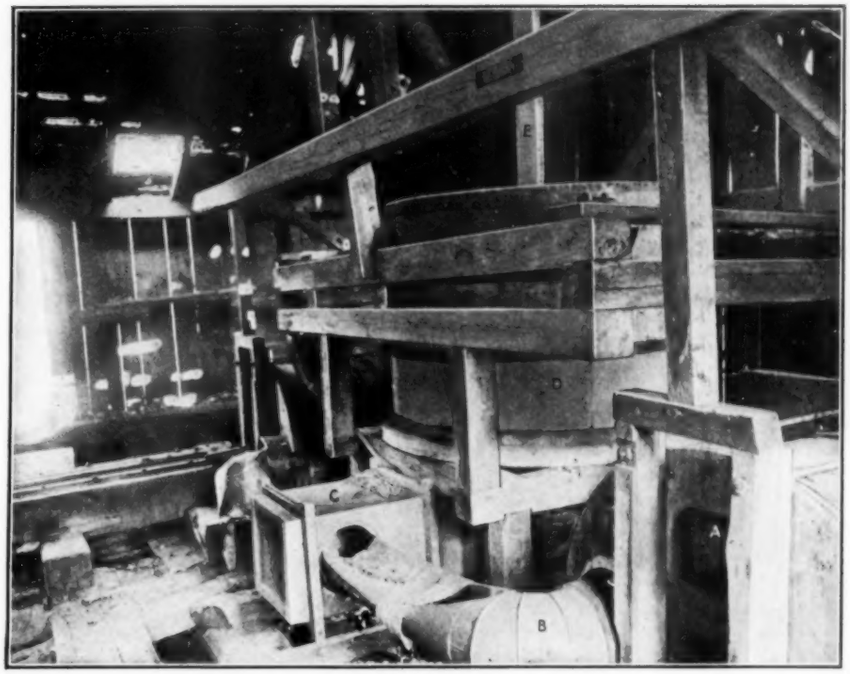


FIG. 3. GENERAL VIEW OF THE BLOWER ROOM

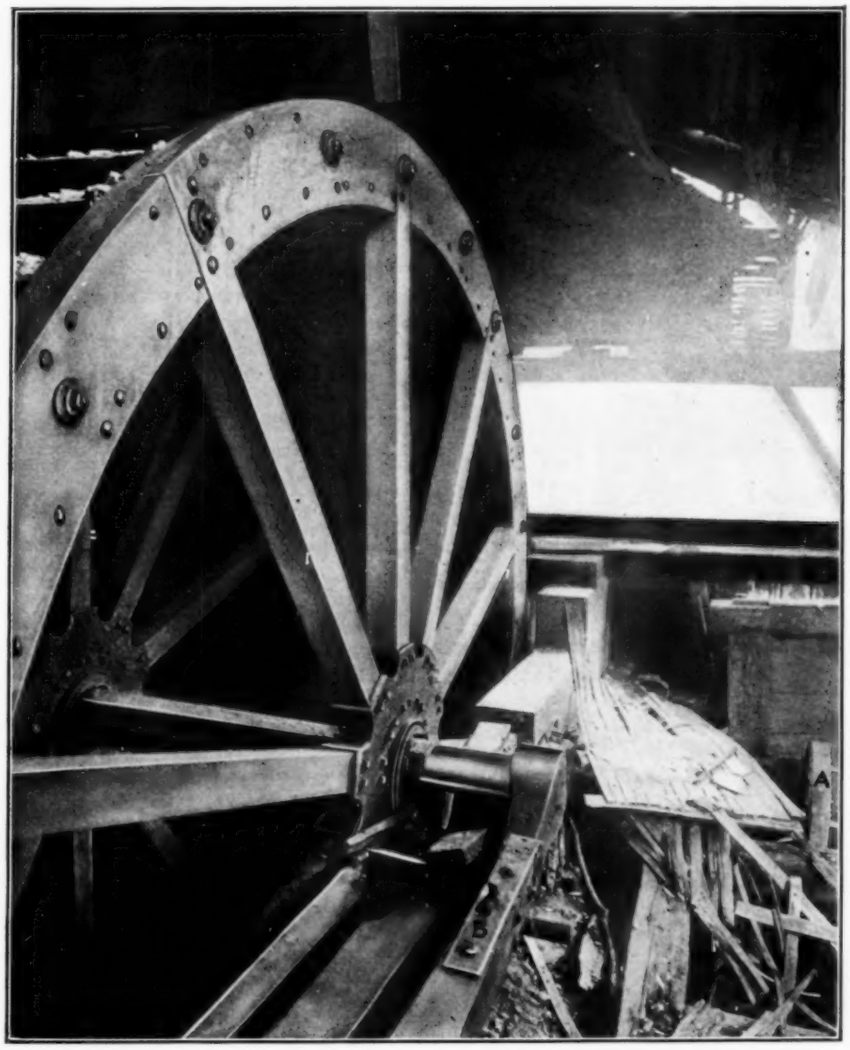


FIG. 2. THE WATER WHEEL

At intervals near the top around the accumulators *D*, rows of holes are drilled through the walls. These act as safety valves, relieve the pressure and prevent the piston from being blown out should the blowers supply more air than can be used.

From the blower house the air pipe led over to a large chamber near the top of the furnace where the air passed through a heater, run by the waste heat from the furnace, which transformed it into hot blast and from here it was led at about 8 ounces pressure down to the tuyeres.

While the blowing apparatus dates back to the early part of the last century, the furnace itself is of comparatively recent date, 1885, and is therefore of little interest for this article, except as far as the making of charcoal iron is concerned.

The big barn in the left background in Fig. 1, was the coal house, where 60,000 bushels of charcoal were stored.

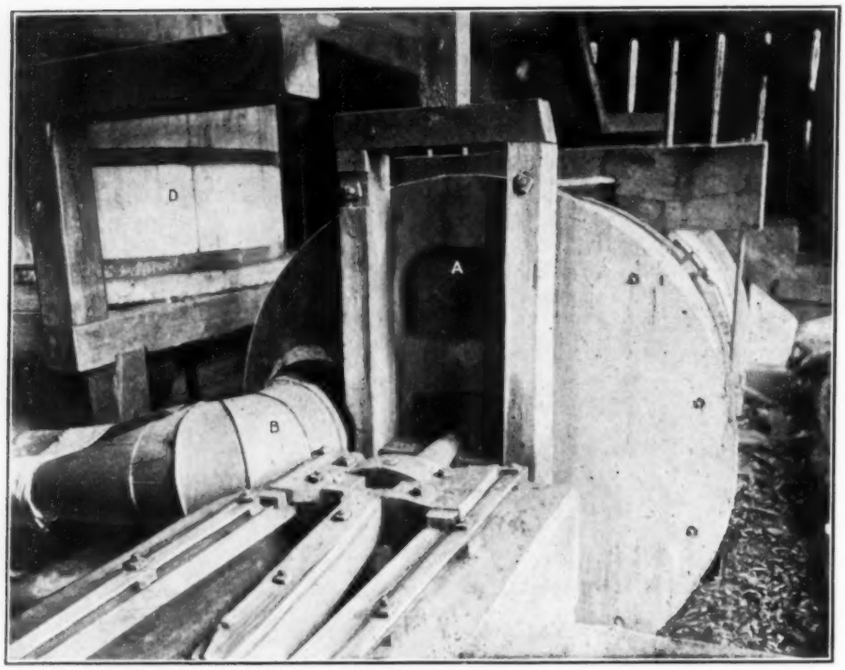


FIG. 4. ONE OF THE WOODEN BLOWER CYLINDERS

Mr. Ives, who now has the hotel at Kent, told me that for years he burnt and hauled from 15,000 to 20,000 bushels of charcoal each year for Kent furnace, beginning in July and finishing up when the snow put a stop to the work. The big barn full of charcoal took fire once and a spectator told me that it was impossible to get nearer than 300 feet, so intense was the heat.

The ore used was Salisbury and Kent, both good. It was broken to the size of a man's fist, but the charcoal was charged just as it came. Ore cost as high as $4 per ton, and charcoal from 6 to 20 cents per bushel, while limestone cost $1.25 per ton.

Walter Barker was foreman at the Kent furnace for about 15 years and before him his father, who died recently aged 90 years.

In conversation with Walter Barker a few weeks ago, he gave me the following facts: The output per day was from 12 to 17 tons. A charge consisted of 30 bushels of charcoal, 1200 to 2000 pounds of ore and 150 pounds of limestone. These charges were put in at intervals of half an hour or so; as soon as a charge melted a fresh one was put in. In order to ascertain whether a charge was melted or not, an iron rod was lowered from the charging hole until it rested on top of the new charge. As soon as melting began the rod would move slowly downward, upon which a new charge would be put in. The furnace was tapped twice daily.

The men worked twelve-hour shifts and their duties were as follows: Two firemen, at $2 per day, attended to the cooling water and drew the cinder out as it ran from the furnace. Two helpers, at $1.50 per day, molded the pig bed, took the iron out of the bed and helped the firemen generally. Two guttermen, at $1.50 per day, drew the iron and cinder from the furnace and piled the cinder to one side. Two fillers, at $1.50 per day, put in the charges of ore, charcoal and limestone every half hour. Two oremen, at $1.50 per day, put the ore into the top house handy for the fillers. Two coal men, at $1.50 per day, performed the same duty with the charcoal. One foundryman, at from $100 to $125 per month, had charge of all the other men and oversaw their work.

The average price paid for iron was $40 per ton at the furnace, but in war times the price rose to from $100 to $125 per ton.

Kent furnace was the backbone of Kent's prosperity and while I was there, taking the photographs and measurements for this article and talking to various men who had worked there, one of the older men, thinking, probably, that I was looking the place over for a possible purchaser, asked me in a wistful voice:

"Is there any chance of the old furnace being started again? Is someone going to buy it and start it up?"

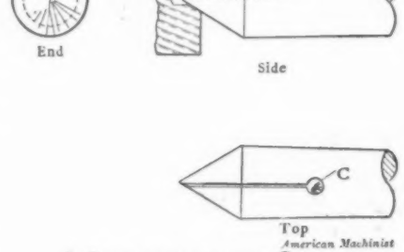
When I told them I was merely getting material for an article they looked on me as a mild lunatic for taking any interest in a dead furnace.

A Self Lubricating Center

By A. F. Kunze

The difficulty of keeping lathe and other dead centers lubricated so that they will not get excessively hot is well known to most of us. The pressure of the center against the surfaces of the countersink squeezes the lubricant out, and if the work is revolving rapidly there will soon be a hot bearing and consequent burning of the center.

The accompanying sketch shows a center which we recently devised to overcome this difficulty. A very thin slot (about 1/32 inch, or even 1/64 inch, will do) is cut into the cone a little to the side and above the center lines, as shown at *A*, front view. It is run back as far as desired, about an inch or so, which will allow for grinding many times. At the end of the slot a little countersink



A SELF-LUBRICATING CENTER

C is drilled, which is convenient to pour oil into.

The effect of this method is seen at *B* where the slot acting as a reservoir for oil or white lead will constantly lubricate the surface of the revolving countersink in the work. The edges of the slot should be stoned a little after each grinding to prevent any possibility of cutting, which can also be largely prevented by placing the slot off center. This center is very simple and seems to answer the purpose for which it was designed.

At the beginning of the present year nearly 7,000,000 telephones were in active use in the United States. With a population of 85,000,000, telephone development is pre-eminent in this country, for Europe, with a population of 400,000,000, had only 2,300,000 telephone instruments in use at the same date.

Selecting and Using Pyrometers

By C. Conam

In considering the installation of pyrometers for the control of furnace temperatures, in a works where a number of instruments are to be used, one of the chief points to be studied is the type of instrument. For it goes almost without saying that it is necessary to use, as far as possible, one type of instrument so that interchangeability is permitted. There are many other points needing close attention when this decision has been made, but at first this one stands well to the fore, and must be settled.

The two kinds of pyrometers that will attract attention, and which fulfil many of the requirements satisfactorily, are the thermocouple and resistance types. Much may be said for—and against—both these types of pyrometers, but in the end the thermocouple proves to be for general work the most suitable and satisfactory instrument.

The resistance pyrometer is very accurate in its indications, but the range of temperatures through which it acts is, as a rule, very much more limited than that of the thermocouple. This is very important, and must weigh in the balance seriously against the former type of instrument. Then again the high first cost of the resistance pyrometer, compared with the thermocouple, is another serious point. This is particularly noticeable when recording instruments are required, and in this case the controlling mechanism is very much more complicated than in the thermocouple, and requires the attention of a skilled man for regulation and adjustment.

Errors in Thermocouple Instruments

There are many points about thermocouples which require careful attention, and if neglected may lead to serious errors and losses. The first point that comes to my mind is that the internal resistance of couples and leads may vary with couples made from the same standard wires. This variation may be due to differences in the lengths of the couples and the leads, and the result is that all the couples will not indicate the same temperatures when their hot junctions are side by side in a furnace. This error does not exist if the internal resistance of the indicating millivoltmeter is very high, but as the indicators generally used by engineers for pyrometrical work have a resistance of about 100 ohms only a variation of, say, 2 ohms in the couples will be an appreciable percentage of the total resistance of the circuit, and will consequently show an error of that amount in the temperature indicated. It is quite possible to get an error of from 30 to 40 degrees Fahrenheit in this way.

There are two methods of overcoming this difficulty. The first is to increase the resistance of the indicator to such an amount that any normal variation, due to difference in the length of couples and leads, is made entirely negligible; and the second is to bring all the leads to one standard resistance by inserting coils of fine wire, and all the couples to a standard resistance by the same method. With the couples, the coil may be conveniently placed in the cold junction box.

This second method is open to the objection that the cold junction coils are liable to be raised considerably above their normal temperature by reason of their close proximity to furnace walls, etc., and so have their resistance increased. This increase, however, even if the cold junction box is raised by 80 degrees Fahrenheit—and with proper care it would never reach a point that much above the normal—is so very slight that the error is not appreciable and can be safely neglected.

Protecting Covers

Thermocouples adjusted as above to the same standard resistance, side by side in a furnace, with cold junctions at one temperature, and everything equal but the type of sheathing or protecting cover, will not even then show the same temperatures. As all other faults have been eliminated, the cover is the only possible cause of the error, and it is a fact that different kinds of covers create errors sometimes amounting to 20 or 30 degrees Fahrenheit.

It is absolutely necessary that all sheathing for thermocouples should be as far as possible of the same nature. For ordinary furnace work all that is necessary is an iron tube, solid-welded at one end, and this kind of cover finds the most general use. In special cases such as for use in the lead bath, or with high-temperature metallic salts baths, this form of sheathing affords no protection against the penetrating action of vapors and gases, which rapidly destroy the couple wires.

In cases of this description special kinds of sheathing are necessary, and one that may be safely used consists of an outer tube of steam piping, solid welded, containing a smaller solid-welded tube heavily plated on the outside, which, in its turn, contains the couple. This sort of cover can be used for a very long time with the simple reversal of the outer sheath when necessary.

Porcelain Quartz and Fireclay Tubes

Many other forms of protecting tubes are used, including porcelain quartz and fireclay. Porcelain does not find much favor as it is liable to crack at high temperatures. Quartz tubes are used to a moderate extent, and are valuable because they are comparatively rigid even when hot, and may be subjected to violent changes of temperature without cracking; such as being plunged into molten metal when cold. They are, however, only impermeable to gases at temperatures not exceeding 1800 degrees Fahrenheit, and even at that temperature should be used intermittently as their impermeability breaks down with constant use.

These tubes rapidly rise to the temperature of the furnace, and consequently indicate changes of temperature very readily. Marquardt tubes will stand a very high temperature without losing their impermeability to gases, but they are of little practical value as they will not stand rapid changes of temperature; nor must they be put into a position where there is likelihood of their being knocked or affected by vibration, as they are very fragile, and liable to crack. They, moreover, have to be placed generally in a vertical position, as they readily bend at high heats, and if placed horizontally may break of their own weight. They can be used under favorable conditions up to 2800 degrees Fahrenheit. In all cases where these protecting tubes are used it is usual to give them the extra protection of a sheath of wrought-iron tubing.

Why Protection Is Necessary

It is necessary to protect the cold junction of a couple as much as possible from the action of the hot furnace gases and from the radiation of the furnace. It is obvious that the position of the couple will have a good deal to do with the former action. It is better to insert the couple through a small aperture in the side of the furnace, than through one in the roof. In all cases a fairly good protection, and one that will allow the cold junction to be kept at a fairly low temperature, consists of a sheet of asbestos millboard with the couple passing through the middle. This, if the millboard is large enough, deflects the hot gases, and arrests the radiant heat effectively. In cases where the cold-junction temperature must be kept very uniform the cold-junction box

has a water jacket through which water continually flows from the mains. This is quite unnecessary in works practice.

The insulation from one another of the couple wires is a simple matter, as porcelain tubes, double drilled, about three inches long, and one-quarter of an inch in diameter, can be purchased from most wholesale chemists. Small balls, doubled bored, are also used for this purpose, especially when the couple sheath is of a special shape, say, right-angular. Small-diameter quartz tubes are also made for this purpose. It is very important to see that, in building up a thermocouple, the wires are not twisted and touching between each insulating tube, for, if they do touch, a false junction is thereby made, and the indicator readings will be wrong.

Calibration is a very troublesome operation to some people, but if ordinary care is taken it should not be at all difficult. This has been dealt with, however, quite recently in the AMERICAN MACHINIST fairly thoroughly, so there is no need to repeat the process.

Tools for a Difficult Lathe Job

By Robert O'Neal

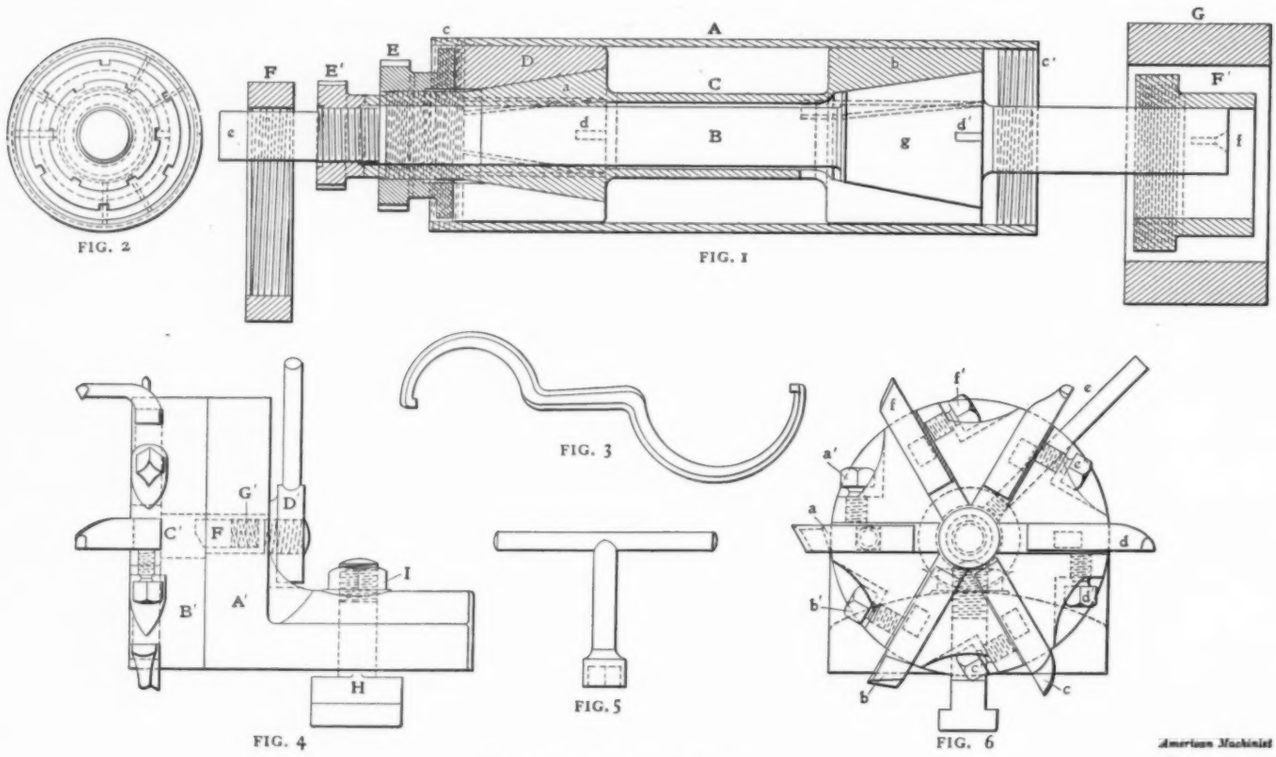
Some years ago, while leading a somewhat nomadic mechanical life, I dropped into a shop that made a specialty of small work, duplicate parts, models, etc., and the required accuracy was well above the average, as will, I think, be clearly shown in the article here described, which was being made by them in lots of 1000.

The article, a hollow cylinder, shown in its longitudinal cross-section at *A*, Fig. 1, was about 2 inches inside and 2⅛ inches outside diameter and 13 inches long, threaded, as shown, 20 threads per inch. The inside was to be reamed and the outside to be a ring-gage fit throughout its entire length. The threads were to fit the gages furnished by the company having the work done, a set of two, male and female, being sent with the order, as was also a snap gage, so constructed as to gage the length over all, and the same time the end facings, which must be parallel.

To show the device, and the result from its use, it will be necessary to show the method in vogue prior to its advent, which was as follows:

A brass tube of the required diameter was cut into lengths of 13¼ inches. A 2-inch reamer run through each length, when one end was chucked to run true in a lathe, while the other, in a steady rest, was being faced and the outside thread was chased. This was called the first operation, and was followed by a second in which the chuck was removed and a piece inserted in the lathe spindle and chased to receive the threaded end of the tube which, running in the steady rest, was faced off to length and chased at the other end. The rest now being removed, a plug was inserted in the tube and the tail center brought up to support the work while turning to within about 0.01 inch of the required diameter, this amount being left to be removed by the grinder on which the ring-gage fit was made. Thus, it will be seen, the work was carried through four distinct operations, and as only about 70 per cent. of the finished product would pass the test for accuracy the average cost per tube was about $2, although this may not seem to be excessive when it is stated that $5 per tube was the contract price. After a day or two on the job the fixture, shown with the arrangement of tools as Figs. 1 to 6, was suggested, made, tried out, and it was found that a tube could be finished complete without removing from the fixture in about 40 minutes.

In Fig. 1, *C* was bored as shown. *B*, nicely fitted at *a b* and secured thereto



A SPECIAL LATHE FIXTURE

by nut E', was used to finish C. D, being fitted over C, as shown at a, and secured by the nut E while turning the outside diameters of both D and b to slide freely through the tube A. Thus it will be seen that all parts are concentric with the mandrel B. The bushings D and b, being slotted, as shown by dotted lines, were fitted over the pins $d\,d'$ driven into the tapered parts of a in C, and g in B, to prevent slipping.

The thread gage F was hung on the end of the lathe spindle, the end e of the mandrel B being caught in the draw-in chuck. The tube A was cut to length, reamed, and slipped over the fixture allowing sufficient overhang for the thread at c'. On turning the nut E the bushing D was forced along the taper part a, and expanded firmly against the wall of the tube A. So, also, with b. When the nut E' on B is operated, the nut E and the bushing D being mounted on the part C, and in contact with the inner wall of the tube A, the entire mass is moved through the same space at the same time and continued until b is brought in contact with the tube A, without in any way disturbing the bearing of the tube at the point of contact with D, this contact being evenly tensioned with the spanner wrench, Fig. 3. The tube is rigidly held in position while being turned to the required diameter and faced off and chased at both ends without removing, and its concentricity is very near absolute. The ring gage G and the thread gage F' bored, as shown, were hung upon the tail center for convenience and the job was set up ready for tooling.

The tool post being removed the little turret, shown in Figs. 4 to 6, was secured in its place by the T-head bolt H. The necessary tools $a\,b\,c\,d\,e\,f$, secured by set screws $a'\,b'\,c'\,d'\,e'\,f'$, Fig. 6, in slots cut in B', Fig. 4, which revolved around the bolt C', bringing the required tool in the desired position with respect to the cutting edge and center of work by means of the stop pin F'' engaging pockets cut in B'; the part B' being released to allow of easy manipulation and afterward secured rigidly by the nut D' operated by the lever E'' and the bolt C' being threaded left hand, which brought the lever E'' to the operator and out of the way when secured. The pin F'' receding in the body A' when the tool head was being revolved was thrust out by the spring G', thus surely locating the tool in the proper place. A socket wrench, Fig. 5, completed the fixture.

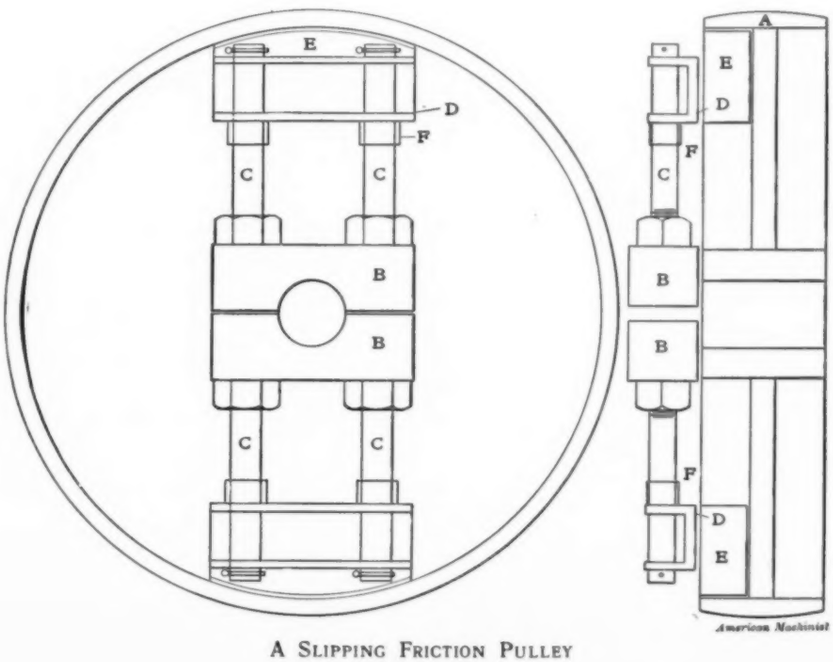
With this outfit one man easily finished, complete, 12 tubes a day with a loss of less than ½ per cent., and this invariably due to carelessly chasing the threads too loose. The little turret was found to be adaptable to several jobs requiring successive tool changing and some two or three were made and put in use with satisfactory result.

The boss, who was also the shop owner in this case, was, if I may use his own expression at the time, "always ready to recognize worth, and reward it accordingly," so well pleased with the device that he offered the munificent sum of 10 cents a day increase of the pay to the designer of the fixture. However, by this time my treasure had already assumed abnormal proportions due to the savings accruing from $2.50 per diem, and prefering variety to wealth I gathered up my little "kit" and moved on.

A Slipping Friction Pulley

By P. Robinson

The pulley described was made from material found in the scrap heap, and the idea was to start a hydro-extractor without straining the belts or slowing down the engine. The pulley is fixed on a countershaft, carrying a small fast and loose pulley. The pulley proper is A with the inside of the rim turned, runs loose on the countershaft. B is the hub formed by two pieces of square section iron. C are the arms clamping the hub and carrying friction blocks. D is a channel or iron angle iron with an elm block attached. E are elm blocks shaped to fit the inside of the rim of the pulley. F are two short pieces of rubber tube to act as collars, keeping the friction blocks E in their respective places.



A Slipping Friction Pulley

The action is as follows: The belt-driving countershaft being moved from the loose to the fast pulley causes the arms E to turn at full speed, the centrifugal force causing the blocks E to bind on inside of the pulley, the load on the pulley A being started gradually until full speed is reached, the rate of acceleration or adjustment being made by altering the size of the blocks E, or by adding ordinary iron washers between the rubber tubes and the blocks. The pulley has been at work about four months and leaves nothing to be desired.

High Pressure Tubing

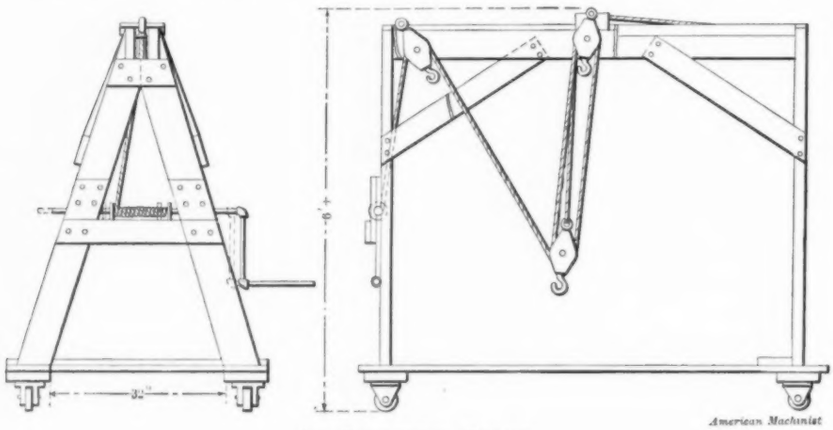
In a paper read before the Institute of Marine Engineers dealing with the characteristics of copper under various conditions, it is noted that the substitution of steel for copper in cases of high steam pressure and other directions has developed rapidly since the production of the seamless steel tube—a distinct improvement certainly when correctly designed, and adequate provisions made for its characteristic action. It is to be noted that the bicycle trade is really responsible for the large development of the seamless steel-tube industry in this country. At first difficulty was encountered in obtaining the proper steel for making seamless tubes but the large demand in bicycle manufacture led to importation of the proper grades.

LETTERS · FROM · PRACTICAL · MEN

Concerning the Details of making things in machine shops, from the first sketch to the sale

A Homemade 1000-Pound Emergency Crane

The terms of an installation contract specified that any delays on the part of the contractor would be charged for at a pretty stiff rate. There were some forty-odd motors to set up and over half of them weighed about 1000 pounds. The old factory was continued in operation and the machinery moved into the new building one piece at a time. As these followed no particular order in regard to the motor sizes, the erecting engineer could not tell when he would have to have helpers ready and he soon found that the cost of keeping three or four men on the job would lose money on the contract.



AN EMERGENCY CRANE

It was therefore evident that some means for handling and placing the motors at less cost was needed. A portable crane was suggested but none could be obtained in the city and telegraphic inquiry showed that manufacturers could not make delivery under two weeks; which delay, together with the cost of the help for that period would not have improved matters. Help was too scarce and high-priced to think of hiring men whenever wanted. The only solution seemed in making a temporary crane. This was decided upon and the outfit described below was made up and put into use within 24 hours.

The motors being something like 27 inches in hight and the maximum lift required about two feet it was necessary that this be allowed for. The settings of some of the motors were such that it was impossible to place them unless a traveling head or carriage be provided. With these restrictions and also that the crane should be operable by one man and portable, it was laid out as follows:

Taking a bench horse as a model, 1½ x6-inch planks were cut and assembled into A frames, as shown in the illustration. Connecting the A frames were two crossbeams of the same material, set on edge with a 1½-inch space between. Bracing strips and cross pieces were added and planks running the length of the horse under corresponding legs on each side, tied together at one end, made the whole very rigid and provided surfaces for the 4-inch castors. Leaving the one end open made it possible to run the crane over the motors, pick them up perpendicularly and set them in like manner.

Two light 2½-inch double-pulley blocks and a single pulley of the same type were selected to take up as little head room as possible when drawn close together. This was necessary because six feet two inches was the limiting hight allowed by the elevator doors in the building. A traveling head was made of a sliding piece of wood guided by nailed strips outside of each cross beam. The upper block was held to same by a piece of gas pipe running through the eye and resting on the two runners of the traveler.

The windlass proved a puzzler at first but the solution was interesting. Using a ¾-inch gas pipe and elbows, it was constructed as shown; the crank and shaft being of the same material. Bearings were provided by wooden strips soaped to keep the friction low. In order to lock the windlass, the washers provided to keep the ½-inch flexible elevator cable in place were set close enough together so that the shaft could slide inward and allow the crank to strike the leg of the horse. The single pulley was placed at the upper corner directly over the windlass and so acted as a guide to the cable regardless of where the blocks were located. The side pull thus brought to bear on the traveler was resisted by a cable from the traveler to a fixed point on the opposite end of the horse. This made it possible to slide the traveler with a load when the beams were soaped.

It was found that a pull of about 30 pounds on the crank was sufficient to lift 1000 pounds. A test was made for the safety of the apparatus by lifting 2500 pounds. The crane filled the bill admirably and it was interesting to note how the electricians, steamfitters and other skilled mechanics who laughed at the clumsy affair, afterward used it to advantage in their own work. At one time the electricians were able to pull a large cable into a conduit where their large block and tackle could not be used on account of limited space. They placed the crane on end against the wall and nearly put it out of business by their efforts with two men at the gas-pipe crank. The total cost of the crane was less than five dollars and a 10-hour day's work of one man.

J. G. ZIMMERMAN.

Milwaukee, Wis.

A Landsman's Plumb

It was a large P. and O. liner, and she had left the stocks some time previously, as the various subcontractors were well advanced with their work. The firm who was supplying the hydraulic installation was very anxious to know how its part was progressing, so the managing director rang up Bilson, their man in charge. He replied that he could not say exactly when he would be ready for the test, as there were several things to do, and besides there was something wrong with the accumulator.

On receiving this information the boss at once consulted the new manager, Mr. Head, and he decided he would investigate on the spot, and at once made tracks for the yard.

On his arrival he was somewhat shocked at the unconcerned manner in which he was received, but was eventually conducted to the engine room and

Bilson in a somewhat ruffled state of mind.

"Now, Bilson, what's all this fuss about the accumulator?"

Bilson, although he had been for years in charge of this branch of the firm's work from A to Z, returned a soft answer, "I didn't know there was any fuss; something was wrong with the accumulator, but I do not anticipate any trouble. I have not looked at it yet."

"Not looked at it yet? Hold this mackintosh and *I'll* look at it now. What are *you* here for?"

There was an interval of about two minutes, Bilson not being occupied with anything in particular except his duty as clothes peg.

"There is not much to make a fuss about, after all," said Mr. Head, "any fool could see with his *mouth* what is wrong. *It's out of plumb. Get me a spirit level.*"

Five minutes later Mr. Head had disappeared to the advantage of his own firm and several others, as every man on that ship had laid aside his tools in the earnest endeavor to find the object demanded by Mr. Head.

Bilson (whose permission I have to tell the story) is still busy with hydraulic installations, and he has one man under his charge who now knows that hydraulic accumulators are not intended as columns to support the deck above. Bilson told him so.

Mr. Head never forgot the incident; his friends would not let him; but he left to investigate another matter some time ago, and is not expected back.

Belfast, Ireland. TERRY.

Tool for Turning Balance Lobes on Small Crank Shafts

There were a lot of crank shafts to be made as shown in Fig. 1, and one of the operations on them was to turn the lobe at *A* to a radius 5/16 less than that made by the outermost point of the crank pin to balance the crank shaft.

This operation was done for some time by fixing the cross-slide stop as for screw cutting, then with the tool set for taking a cut, as the crank shaft revolved, the tool was withdrawn by the cross-feed screw, worked by the operator, far enough to allow the crank pin to pass, and then fed forward again up to the stop in time to take another chip off the lobe, the carriage being fed longitudinally meanwhile, as for turning. This method, as most turners know, is a tedious one. After being on the job for some hours, and getting tired of it, I devised the tool shown in Fig. 2 for doing the job. It is automatic in action and is very simple, cheap and effective.

The sketch shows the tool and holder in position in the open-side tool post. The cutting tool is shown in two positions, *b* and *c*. At *b* it is in a position for taking a cut, and at *c* in the position to which it is lifted to allow the crank pin to pass. The dotted lines *d* and *e* represent the amount of metal to be removed, and the circles 1, 2, 3, 4, show the path of the crank pin.

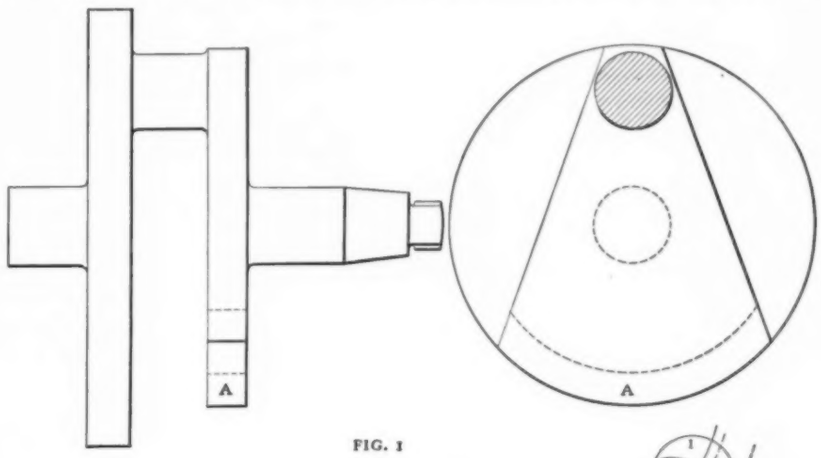


FIG. 1

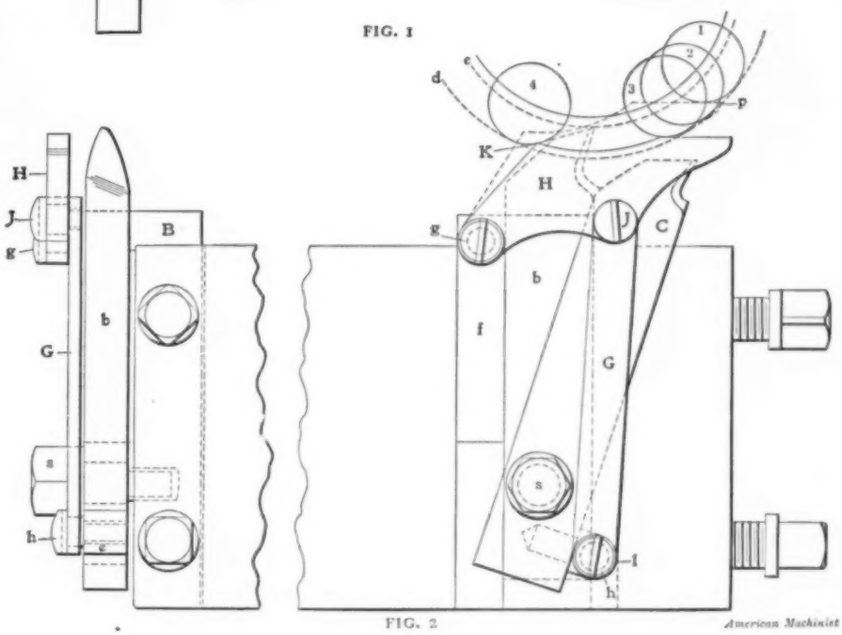


FIG. 2 American Machinist

TOOL FOR TURNING THE BALANCE LOBES OF SMALL CRANK SHAFTS

The complete tool consists of nine parts. The body *B* which is shaped to form a ledge *f*, upon which the tool is supported when taking the cut, and drilled to receive the shouldered screw *S*, and round-head screw *g*. The cutting tool is an ordinary turning tool made flat on the inner side and drilled to receive the screw *S* upon which it pivots. On the top it is drilled to receive eye pin *I*, to which is attached, by means of screw *h*, one end of the connecting link *G*, the other end being attached to the push plate *H* by a similar screw *J*. The lower end of the push plate *H* is attached to the body *B* by the screw *g* upon which it is free to rock.

The action of the tool will readily be seen. As the crank shaft rotates the crank pin comes in contact with the push plate *H* at the point *P;* as it continues to rotate the plate *H* is pushed backward together with the strap *G*, which acts upon the tool through the eye pin *I* causing it to be lifted high enough to clear the crank pin and remain raised until it has passed the point *K* when it drops of its own weight in time to take a chip off the lobe as it comes round. The tool is quite a success; the time required to finish a lobe being reduced by more than one-half; i.e., from twelve minutes per piece to five minutes. Moreover, the job is as easy as ordinary turning.

London, Eng. G. HOULTON.

A Centering Job in the Lathe

A lathe hand was caught recently truing up a forging between the lathe centers preparatory to centering. He centered the end next the faceplate and placed a block of wood between the other end and the tail center. Screwing up

the tailstock center enough so that the piece would swing safely, he tried the piece with the tool in the tool post, using a hammer to shift it sideways. When it was found to run true enough the steady rest was applied, the block removed and the center drilled just right. This idea may not be new to all, but it is without doubt a simple one.

Elyria, Ohio. MILES A. HARRIS.

A Special Bit Grinder

The accompanying views, Figs. 1 to 3, show a bit grinder, designed to be used in connection with a Greenfield grinder. This machine was made for James H. Matthews & Co., stamp, stencil and large type makers, of Pittsburg, who have several routing machines and use a large quantity of bits. These bits, as shown in Fig. 4, are not eccentric, to allow cutting clearance, but more nearly elliptical in form. They are also made in a variety of sizes, the amount of clearance depending on the size of the bit. The attachment was designed to accommodate all these sizes, as will be explained below.

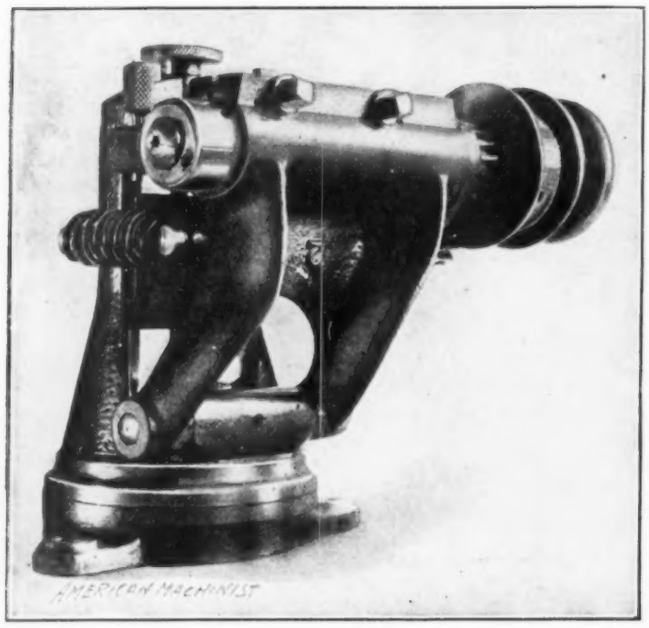


FIG. 1

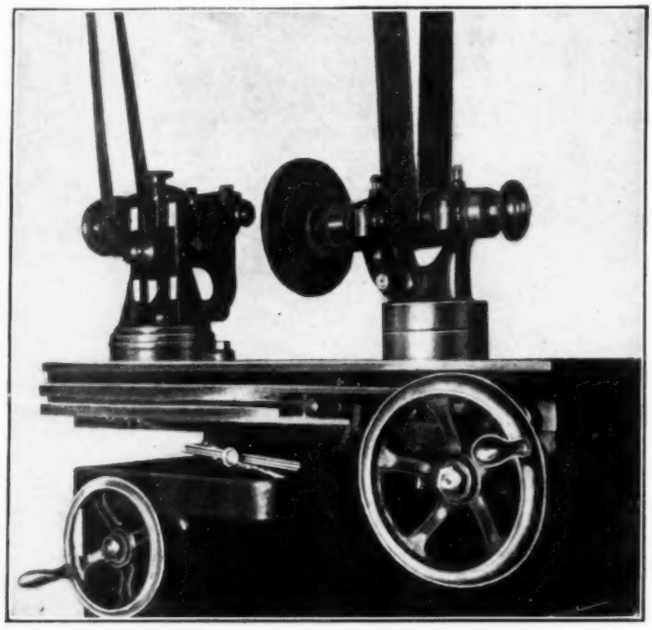


FIG. 2

A SPECIAL BIT GRINDER

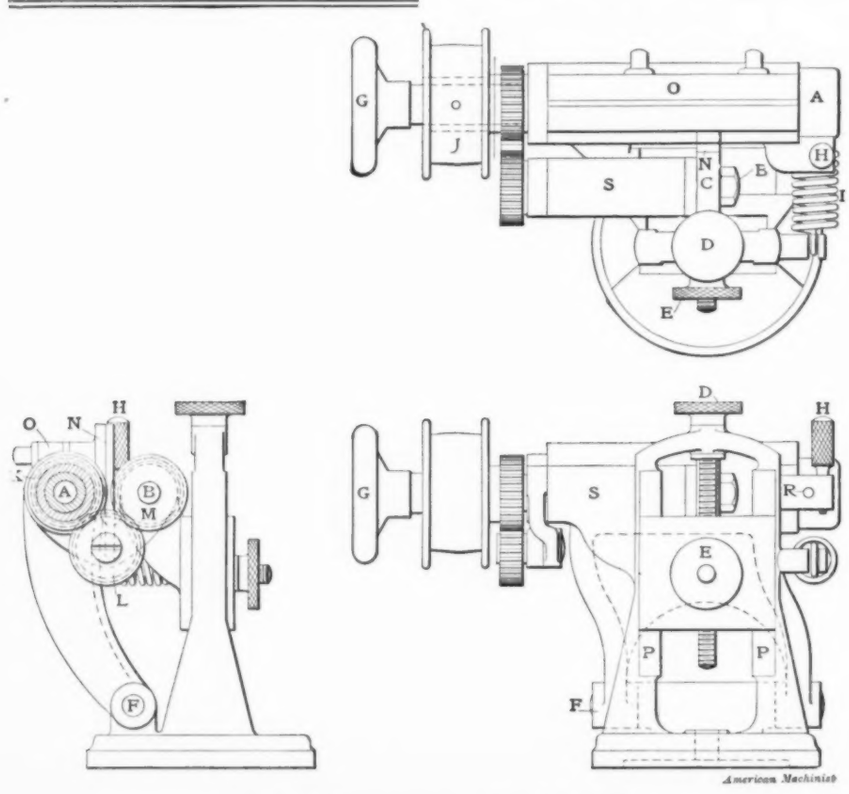


FIG. 3. CONSTRUCTION OF BIT GRINDER

Figs. 1 and 3 show the general arrangement of the machine. The cam shaft *B* and main spindle *A* are parallel and linked together with three spur gears *K L M*. The main spindle runs in a long bearing *O* hinged at *F*. The cam-shaft bearing *S* is arranged to slide in housing *P*, proper adjustment being secured through screw and handwheel *D*. The cam *C* is made to give the correct movement and bears against the hardened-steel plate *N*, tension being obtained by spring *I* located at the side of the attachment.

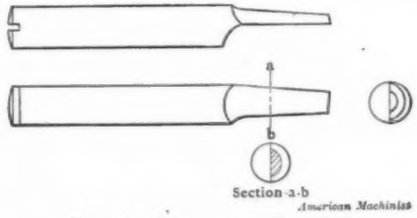


FIG. 4. BIT TO BE GROUND

The bits are held in a draw chuck in the end of spindle *A*, the slot in the bit fitting a corresponding projection in the chuck, thus giving the proper position for grinding. Power is secured through a flanged pulley *J* mounted on the end of spindle *A*.

Fig. 2 shows the attachment as it appears on the grinder. In grinding a bit, it is placed in the chuck in the end of

spindle *A*, tightened up with handwheel *G*, and is fed against the grinding wheel in the usual manner. After the clearance is ground, the attachment is stopped and taper pin *H* inserted in the hole *R* and into the spindle *A*. This locks the spindle in the proper position. The flat surface is then ground.

It is interesting to note the rapidity with which these bits can be made. Drill rod is used and is cut off and slotted in the screw machine, and tempered before grinding. Dull bits are also reground in this manner.

Ingram, Penn. K. P. ROLSTON.

An Indexing Job

Some time ago there came up in the shop an indexing job that had the whole force "on the go" for a while. It wasn't my job, but as it was out of the ordinary I did a little figuring on my own hook, and through a small mistake in addition was led to a solution that may be of interest to some of your readers.

An index plate was required for locating the keyways in a four-cylinder motor cam shaft, and consisted of eight notches in the periphery of a 6-inch plate, one series of four notches equally spaced, and a second series of four equally spaced, but advanced 22 degrees 22 minutes 30 seconds from those in the first series. Indexing either series meant simply 10 turns of the index pointer on the 40-turn Cincinnati head for each notch; but to get the starting point for the second series was the sticking point. The problem was solved in the following manner:

The ratio of the required space is to the circumference as 22 degrees 22.5 minutes : 360 degrees; or, reducing to a common denominator, as 13,425 : 216,000. Dividing 216,000 by 13,425 gives an infinite decimal; but putting the equation in the form of a fraction and reducing to its lowest terms gives $\frac{179}{2880}$. Dividing 2880 by 40 gives the number of the circle required to index 22 degrees 22 minutes 30 seconds, which is 72, and gives $\frac{179}{72}$, or 2 turns and 35 holes in the 72 circle; but it happens that there is no 72 circle on the regular Cincinnati index plate, so the plate was removed and placed on a Brown & Sharpe head set for 72 divisions, and locating from the primary hole in the outside circle, was advanced for 35 spaces and drilled to take the locating pin in the index pointer.

The job was then set up and, starting from the primary hole, the first series of four notches was cut, then two turns of the pointer and an advance to the new hole gave the starting point for the second series of notches.

Through my mistake in addition instead of the fraction $\frac{179}{2880}$ I obtained one whose denominator was not divisible by 40, but as I do not now recall the exact figures I will use the correct ones as they will answer just as well for illustration. Referring to the table of leads obtainable with the spiral attachments, we find a lead of 2.880, or one complete revolution of the index head, for a table travel of 2.880 inches, and as the space required is as 179 : 2880, 0.179 inch travel of the table when set up for 2.880 lead, will give the required location for the first cut In the second series of notches.

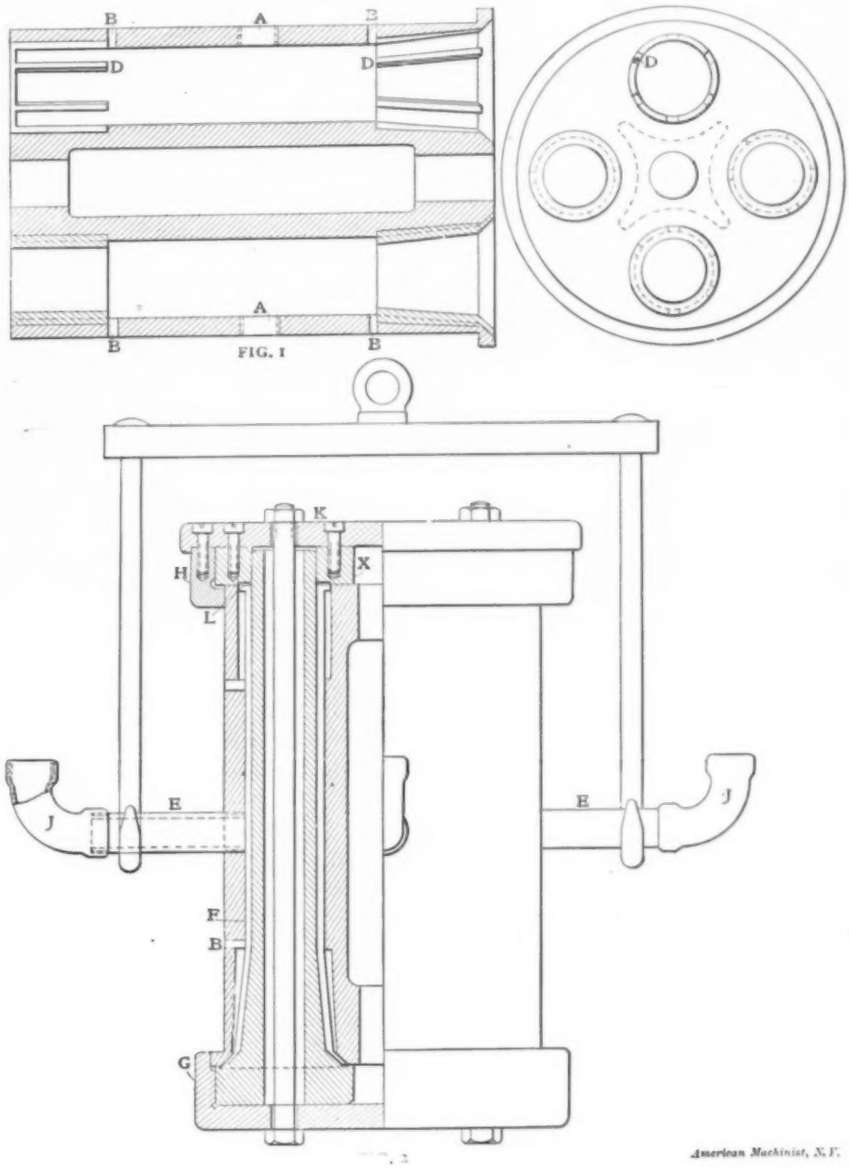
To use this method it is only necessary to set up for a lead of 2.880, throw the gears out of mesh, cut the first series, throw the gears into mesh using care to take up all backlash, release the head, advance the table 0.179 inch, lock the head, throw the gears out of mesh, and index the second series in the regular way. Other indexing problems of a like nature can be solved in a similar manner.

Chicago, Ill. H. M.

An Accurate Babbitting Jig

Fig. 1 is the 16-inch cylinder of a four-spindle automatic screw machine. In the longitudinal section one hole is shown before babbitting and the others after. No machining whatever is done in the spindle holes before pouring the bearings. At each end of the hole are six grooves *D* which, when filled with babbitt, effectively secure the bush against turning with the spindle. These grooves are formed by a part of the spindle-hole core. A hole *A* is drilled and tapped 1¼-inch pipe thread, and two holes *B* are drilled into each spindle hole. *A* is for receiving a piece of tube *E*, Fig. 2, and *B* is an overflow hole for indicating when each bearing is full.

A method of dividing, now quite commonly used, was adopted for spacing the spindles *F*, Fig. 2, at 90 degrees apart,



THE WORK AND THE JIG

and also at the correct distance from the center. The principle of the method will be seen on referring to Fig. 3. Four dummy spindles similar to *F*, Fig. 2, are located at one end by the spindle ends, being correctly sized and fitted into a master ring *G*, which fits snugly on the

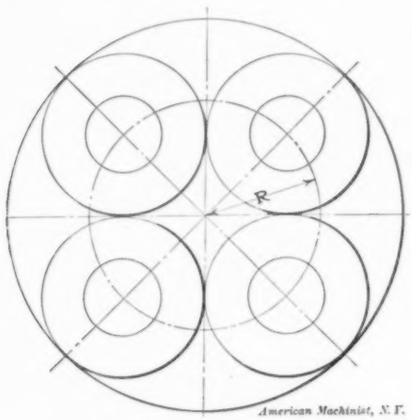


FIG. 3. METHOD OF OBTAINING ACCURATE SPACING

flange of the cylinder. At the other end the four spindles are located by rings *X*, which are ground the same size as the flange end of the dummy spindle and fitted into a master ring *H*. This ring is screwed to a cap *K*, to which are attached the rings *X*. All the spindles and rings are of gray iron.

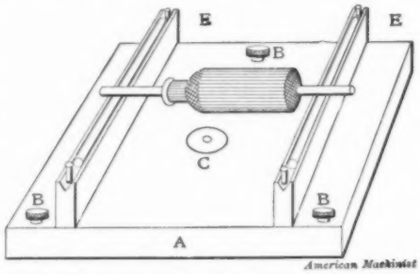
The castings were rough-machined all over and left lying about the shop for a few months to season before finishing. The diameter of the rings *X* and also of the large end of the dummy spindle is obtained by multiplying the radius *R*, Fig. 3, of spindle circle by $\sqrt{2}$. The inside diameter of the master rings is $(2 + \sqrt{2})\ R$. The spindles *F* are ground to the same dimensions for the bearings as the machine spindles except that the rear end is 0.0005-inch taper to facilitate the withdrawal of the spindle after pouring. This taper is scraped away when fitting in the machine spindles. Fig. 2 shows a cylinder assembled with the babbitting jig ready for pouring the conical bushes for the front end. A small recess *L* about 1/16 inch deep is left in the ring *X* and spindle end which allows the metal to be neatly faced off flush with cylinder ends.

It was found advisable to fix the spindles *F* to the plate *G* with screws to prevent a tendency to tilt when assembling the top part of the jig onto the spindles. The parts of the spindles, where the bearings are formed, are smeared with a mixture of oil and graphite to prevent the metal sticking. Before pouring the elbows *J* are all turned upward and metal poured in until it begins to overflow at *B*, the whole arrangement resting meanwhile on the ground. Immediately after the bearings at one end are poured the cylinder is swung over in the sling, the elbows again turned up and the pouring proceeded with. The spindles are usually tight in the holes after the cylinder has cooled down, but they are easily drawn without damage by means of a long bolt through the spindles. The holes *A* are now plugged up with threaded plugs. The accuracy was found to be quite as good by this method as by the previous one of boring.

Glasgow, Scotland. SWAN FIELD.

A Fixture for Balance Testing

Having occasion some time ago to design a simple device for determining the standing balance of small-motor armatures, the balancing ways shown were developed, and have given perfect satisfaction. There are several points of general interest in this device that are often overlooked in designing similar fixtures. In the first place, the "ways" should be as sensitive as possible, and at the same time be of such character as will insure long service. The usual form of "way" is the narrow straight-edge.



A FIXTURE FOR BALANCE TESTING

Theoretically a perfect knife edge would be ideal for the purpose as the friction would be minimized, but in practice this cannot be satisfactory, first, because the knife edge, while appearing perfect to the eye, is in reality a sawtooth surface, as can be easily seen if a strong microscope is used to study it, and secondly, because even if we could attain the perfectly level edge, it would not stand wear and would be of no practical value. The result is that a compromise is usually effected and a narrow straight-edge used which can be made fairly level, and will have some durability. The contact of the rolling shaft on this surface is bad, however, as it is a straight line of contact equal in length to the width of the straight-edge, and it is necessary for the top surface of the straight-edge to be perfectly parallel, or the shaft will not bear the same at various points.

In the fixture shown the base *A* is a plate of heavy cast iron, machined all over to relieve it of "scale strains," and having three leveling screws *B*. To this base are attached two tool-steel V-blocks which are not hardened, but are ground perfectly straight and true in the V after being assembled to the base. In these V-blocks rest the hardened and ground tool-steel balancing rods *E*. It will be seen that the friction in this case is a minimum, being a point contact, or the tangent of two cylinders at 90 degrees, while the ways themselves are mechanically strong and can be turned partly over in the V-block when worn, to get an entirely new line of contact. Besides they are the only parts that wear and are readily duplicated when it becomes necessary to replace them.

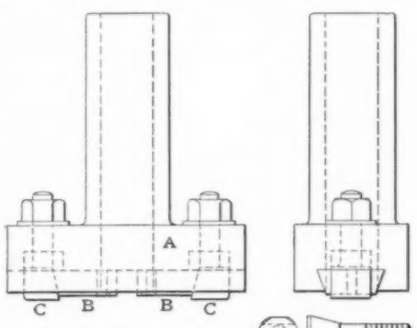
A small circular universal spirit level *C* has been sunk flush in the center of the fixture base and serves to level it. When desired an ordinary bell buzzer may be attached to this fixture and operated with a push button, the vibrations serving to overcome the small friction of contact and make the device a little more sensitive.

Detroit, Mich. C. NOSRAC.

An Adjustable Threading Die for Brass

I once worked in a shop where we had two simple adjustable die holders in use as shown in the sketch. We used these on capstan lathes on brass work for a number of years, with highly satisfactory results, and I understand they are still in use and doing well. Some of the readers of the AMERICAN MACHINIST may have seen similar ones, but I have never dropped across any except in the case in question.

Referring to the sketch, *A* is a malleable-iron holder with hollow turned shank; *B B* are the two die chasers, shown also in the detail sketch. These chasers are a good, tight fit in the dovetail slot shown, and are tapered at the back



ADJUSTABLE THREADING DIE

end. *C C* are the adjusting bolts, which have a flat filed on the heads; these flats come dead against the tapered back end of the chasers, so that when wear takes place on the latter it is only necessary to tighten the bolts to close the die.

London, England. A. L. SHAW.

Shaft Straightening and Finishing in an Irish Shop

The superintendent of a local shop where they turn out shafts varying in diameter from 1¼ to 2½ inches and in length from 1 foot 6 inches to 9 feet, and guaranteed to a limit of 0.0005 inch, gave me permission to describe their methods for the benefit of the readers of the AMERICAN MACHINIST.

The shafts of which they use some thousands in a year are made from black bars 1/16 inch larger in diameter than the finished size. They are first cut to length in a cold saw, the smaller bars being held four and the larger sizes three at a time in a special vise of their own design.

After sawing the shafts are centered in a centering machine alongside of the saw and put into the straightening press shown, which was designed by the manager and has proved its value as a time saver. It will be noticed that it has centers directly over the V's. The center heads *A* and *B* have springs *C D* to raise the shafts clear of the V's when the pressure of the screw *E* is removed, to allow of turning the shaft to locate the twists, the amount necessary being regulated by the nurled-head screws *E* and *G*, shown on the top.

The headstock *A* is also provided with a spring adjustment for the center, this being, I was told, an afterthought, as with both centers fixed they were very easily broken when a badly bent shaft was operated upon. This improvement overcame that trouble entirely. The principal advantage claimed for this press is that it is not necessary to remove the shaft until finished, and it takes very little practice to make chalking the shaft unnecessary. The centers used are much longer than the ones shown in the blueprint to allow for operating right on the end of the shaft if necessary.

After this the shafts are put into a shaving lathe, the ends shaved and chamfered. The over-all length not being to a fine limit, no measuring is required after leaving the sawing-off fixture for length.

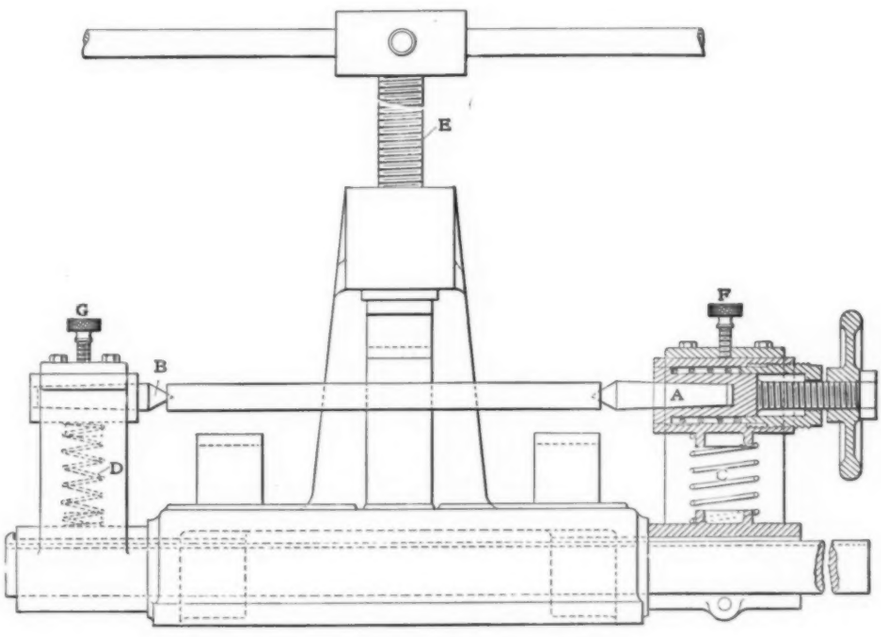
The shafts are next ground to within 0.006 inch of size and passed to the milling machine for cutting the keyways, two being required in each shaft.

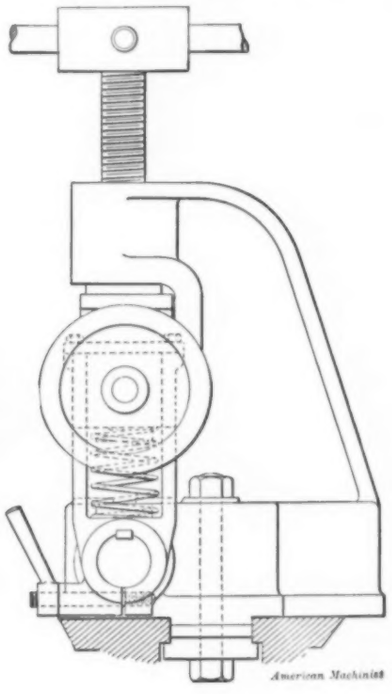
The shafts are held four at a time in a jig, which is really a multiple V-block, the table travel of the machine allowing both keyways to be cut at the one setting. An indicator is fixed on the side of the machine table so no marking off of the keyways is required.

The final grinding is then done to a limit of 0.0005 inch; this grinding operation after the keyways were cut proving a great advantage, as after milling the keyways some of the shafts were slightly sprung and by this means a perfectly true shaft was insured.

The whole of these operations, I was informed, are done piece work on a somewhat novel system, the same price being paid for a 1¼-inch by 1-foot 6-inch shaft as for a 2½-inch by 4-foot, and works out all right for everyone concerned. Put in another way, this means that a piece of black bar 2 9/16 inches by 4 feet long is transformed into a finished 2½-inch by 4-foot shaft with two keyways 7 inches long and ground to the above limit at a labor cost of about 12 cents, and from what I saw I can believe it.

Belfast, Ireland. T. EDDY.





A STRAIGHTENING PRESS AND CENTERS

Fillets and Round Corner Gages

The sketch shows male and female radius gages. These gages reveal the shape of the fillet and measure the work from the fillet to the end of the work.

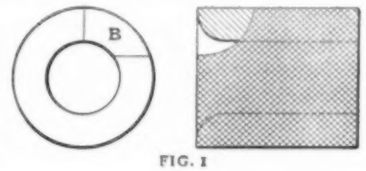


FIG. 1

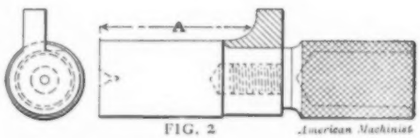


FIG. 2

FILLET AND ROUND-CORNER GAGES

Fig. 2 shows the shape of the fillet and determines the length as indicated at *A*. The other gage determines the length of a shaft in like manner.

Fig. 1 is nurled on the outside and milled away at the center as at *B*, showing the shape of the fillet. The part showing the fillet on the male gage is also milled away as in the sketch. A nurled handle drilled out in one end to lighten it is screwed into this gage. Both gages are of tool steel, hardened, ground, and lapped to size.

Lansing, Mich. B. S.

Air Vents in Dies

By J. M. Stabel

In the construction of compound blanking and drawing, or plain drawing or forming dies no detail is more important and none is more frequently neglected than care against the formation of air pockets. This vitally essential point is, time and again, overlooked by the best of diemakers, and it is probable that 50 per cent. of the failures in this class of dies are due to the fact that air vents of sufficient size either have not been provided or have been improperly placed.

The proper location of the vent is as important, naturally, as the existence of the vent itself. Dies have been scrapped for no other reason than the fact that the point where the imprisonment of air actually would occur had not been recognized by the diemaker who had located the air hole or holes carelessly where they were worse than worthless.

Die Work Can Be Too Good

And a remarkable feature in this connection is the fact that in many instances when means for the escape of air is not provided, the die fails because of too good workmanship. In other words, dies in which "sloppy" fits prevail often need no air vents, for the simple reason that the space between the movable parts is sufficiently great to allow the air to escape, and such dies when the character of the work permits are as successful without air holes as the most carefully built dies in which the close fitting of the parts necessitates the placing of vents.

This does not mean that "sloppy" dies are to be preferred in any kind of work, but that dies so constructed may work, and do work, even if the diemaker has completely overlooked the possibility of air compression.

The lubricant used is an important factor in this air question, and must be taken into consideration. Where tallow or a heavy compound is needed the air vents must be large enough to prevent clogging. A heavy lubricant will sometimes interfere with the escape of air to such an extent as to endanger the die, the gum binding the grit and scale into an impenetrable mass in the air holes.

It is the purpose of this article to show, by means of actual experiences, how tremendously important the air problem is to the diemaker, and to what great expense and trouble neglect or carelessness in this matter is apt to lead. The instances cited here are genuine. The dies shown were constructed by the best toolmakers to be had, and the trouble in every case would have been avoided if the escape of air had been considered, as it should have been, when the die was built.

An Example of Proper Venting

Fig. 1 shows a standard blanking and drawing die with proper air vents, and the cap it makes. The method of construction needs little explanation. *A* is the punch holder; *B*, the knockout pad; *C*, the blanking punch, and *D*, the knockout rod. *E* is a standard cast-iron die shoe; *F*, the cutting ring; *G*, the center forming block, and *H*, the pressure pad. The air holes are plainly indicated.

In the case of dies of this character it hardly seems possible that the necessity of air vents could be overlooked, but that it is possible diemakers of any considerable experience can testify.

The location of the holes, however, is by no means arbitrarily fixed. The chief point to be considered is their placing where they will least affect the strength of the die. Thus, for instance, instead of drilling through the shank of the punch holder the release of air may often be as satisfactorily provided for by milling a slot in the knockout rod.

The reason for the holes through the center forming block *G* is clearly apparent, of course, their purpose being merely to prevent the sticking of the work to the punch.

In order to permit the escape of air from chamber *X* as the pressure pad descends, the pressure-pad pins may be either loose or slotted, one method answering the purpose as well as the other.

It can be readily be seen that failure to provide against air imprisonment in a die of this kind will be likely to result in its destruction.

An Example of Improper Venting

In Fig. 2 is shown a forming die which was not properly supplied with air vents. The possible effect of air imprisonment is strikingly illustrated in this case. It will be noted that the die forms the metal at *B* before the recess at *A* has disappeared, as a consequence shutting in the air at *A*. In this instance, instead of smashing the die the imprisoned air pierced the bottom of the work as neatly as a punch could have done it, and passed through the hole in the knockout pad and out of the punch holder. The stock was No. 11 Brown & Sharpe gage soft sheet brass, 0.091 inch thick. The hole made by the air was about ⅛ inch in diameter, very slightly smaller than the air vent in the knockout pad. This air vent, by the way, should not have been in the center of the pad, but at the outside, although this mistake was not the cause of the trouble. The absence of an air vent through the punch was the real reason for the difficulty and after the hole had been drilled the trouble ceased.

A Sloppily Made Die which Worked Well at First

Fig. 3 illustrates a compound blanking and drawing die like that in Fig. 1, and making a similar cap. This die had not been provided with air vents, but had been made sloppy enough so that the air found sufficient exit at first, and no trouble resulted for a time. It happened, however, that the pressure-pad pins had been made to fit their holes in the shoe so closely that, while the air was all squeezed out of chamber *X* as the pad descended, the sudden release of the pad created a vacuum beneath before the air could return through the pressure-pad pin holes, with the result that air was drawn down through the space between the pad and the punch.

As the job progressed particles of grit and scale shaved from the work were sucked through this space, forming a hard bed under the continued hammering, and accumulating to such an extent as to interfere finally with the required movement of the pad. The time was now about ripe for something to "bust," and something did. The die was pushed through the 1½-inch shoe. This trouble would not have occurred if proper air vents had been supplied.

Fig. 4 pictures a remarkable case in which several thousand pieces of work were spoiled as a result of failure to consider the air question.

This was an "ironing" operation in which the outside diameter of the shell was to have been reduced 0.010 inch, or 0.050 inch on a side, the inside diameter remaining the same as in the preceding operation.

The punch was not provided with an air hole and fitted the shell so snugly that an air pocket was formed at *X*. As a consequence, before the punch had proceeded much more than half way into the shell the compression became great enough to drive the shell through the die, leaving it as shown in the drawing. An air hole in the punch remedied the difficulty.

In Fig. 5 are shown an embossing die and the work before and after the necessary air vent had been supplied. The piece which should have appeared as at *A* after the operation, took instead the form shown at *B*, because of imprisoned

air in the die. After four days of puttering the toolmakers discovered the real reason for the trouble. A minute hole was drilled through the die and the job was successfully finished.

Lack of Vents Sometimes Prevents Stripping

In Fig. 6 appears another phase of the air question. The peculiar feature of this job and its difference from the others we have considered lie in the fact that the lack of air holes did not interfere with the proper forming of the work or endanger the die, but did prevent stripping. It was practically impossible to get the shell off the punch without spoiling it, and in one shop when this job had been attempted the punch was removed with each shell and the work driven off by hand. Of course, this sounds ridiculous, but it helps to emphasize the fact that the shells were sticking rather ambitiously. An air hole through the punch overcame the trouble, and the stripping was thereafter easily accomplished in the press.

Many diemakers have experienced this difficulty and have made new strippers, repaired old ones, and wasted hours and perhaps days in futile efforts to discover the source of this trouble, simply because their education had stopped short of the air problem.

Vents Must Be Properly Located

Fig. 7 shows a flushing die in which the air holes were not properly located. As will be noted in the drawing, the air hole in the center of the punch was useless. No outlet was provided where the imprisonment of air would occur—at the outer corner of the shell—and the result was that the air in effecting its escape squeezed past the corner and between the shell and die, where, when further movement was impossible, it remained, necking the shell, as shown in the cut, and, of course, spoiling it.

Considerable time was wasted before the reason for this trouble was ascertained. At last air holes were provided in the outside of the punch and the job progressed smoothly.

In this article no attempt has been made to treat the air problem exhaustively. To do so would require a volume of American Machinists and a larger experience than any diemaker could crowd into a lifetime. But every diemaker is liable, sooner or later, to bump into at least one of the problems we have considered here; and unless his training has been unusually thorough, it is possible that this article will help nim to save a good die which he might have thrown in the scrap pile had he not been in a position to benefit by the experience of others.

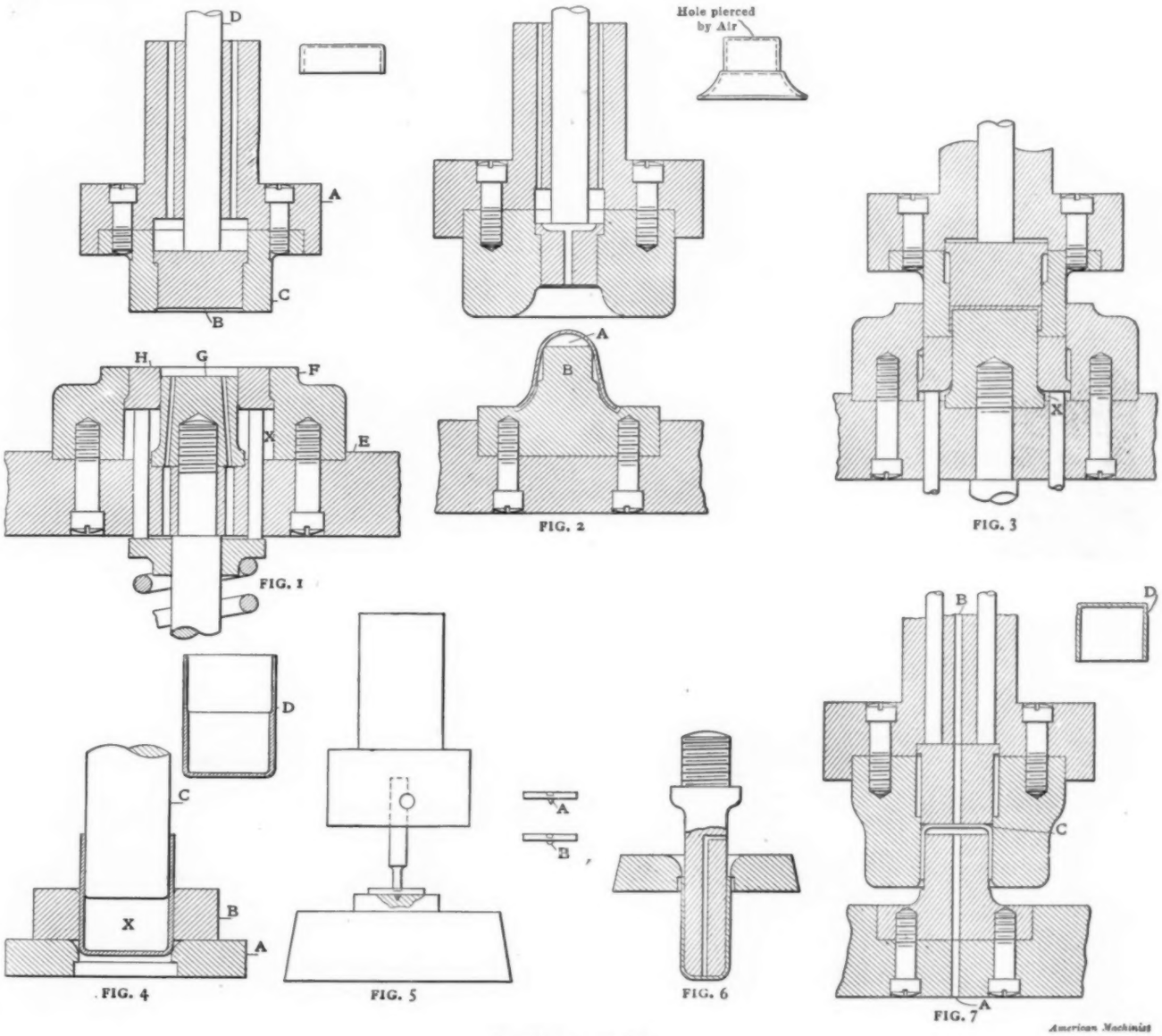


FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5 FIG. 6 FIG. 7

Air Vents in Dies

The Cox Pipe Bending Machine

Editorial Correspondence

The accompanying illustrations show an universal pipe-bending machine about to be placed upon the market by J. Fillmore Cox & Co., Bayonne, N. J. The design covers three sizes, the first capable of handling pipe up to 4-inch, the second up to 8-inch and the third for pipe larger than 8-inch. The smaller machines can be provided with automatic attachments, adapting them for work where a large number of pipe bends of the same size and kind are to be produced.

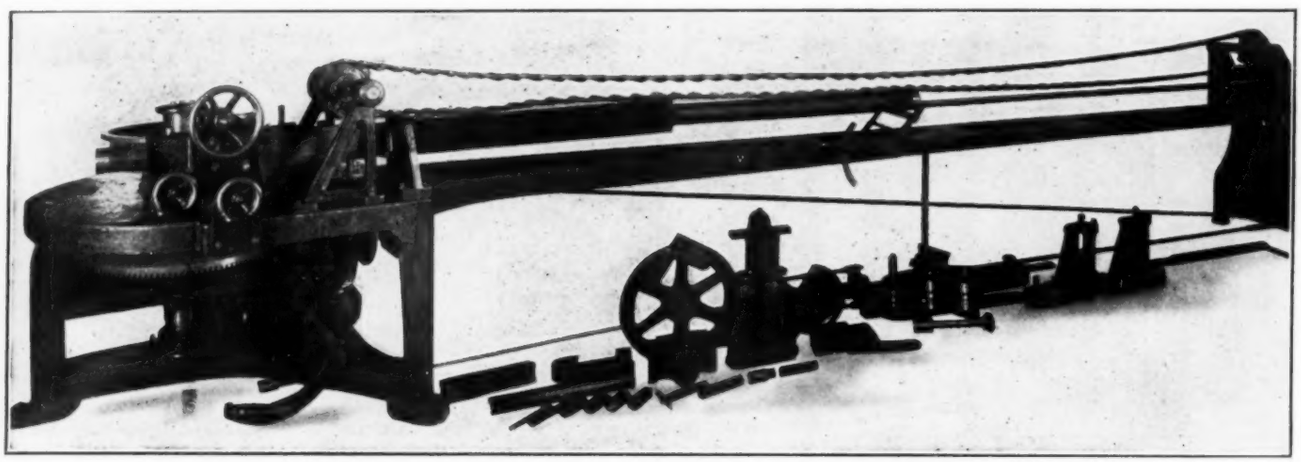


FIG. 1. COX PIPE-BENDING MACHINE

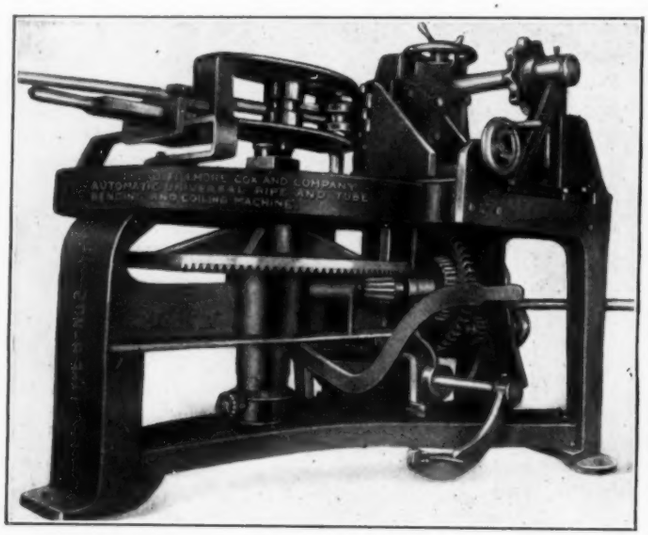


FIG. 2 OPERATING MECHANISM OF COX PIPE-BENDING MACHINE

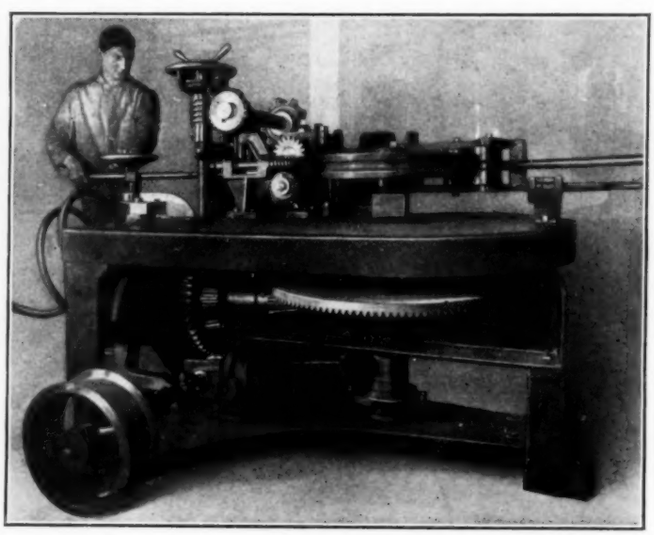


FIG. 3

Turning to the illustrations, Fig. 1 will be seen to show a machine consisting of a head carrying the bending and operating mechanism, and attached thereto a long girder carrying a feeding mechanism. Power is applied at one side of the machine to a flanged belt pulley (see Fig. 3). On this pulley shaft is a universal joint, connected with the shaft of a worm so arranged that it can be engaged with and disengaged from a worm wheel, seen beneath the table of the machine and at the left in Fig. 3. This worm wheel drives through a set of pinions to the large bevel gear directly beneath the table of the machine. On the end of this gear shaft, above the table, is a grooved wheel used for ordinary radius bending. Fig. 2 shows at the left above the table a sliding carriage used for this work. All the bending is done without filling the pipe and is done cold.

To operate the machine a piece of pipe is inserted between the friction rollers and the machine is treadled. This treadling device throws the worm that has been mentioned before into mesh with its worm wheel. On the bottom of the shaft of the large bevel gear is a graduated surface, so arranged that a dog can be set to the required number of degrees of arc to which the bend is to be made. After the piece of pipe which is being operated upon is bent to the required degree the dog throws out a latch that disengages the worm from the worm wheel and the machine stops. Such an adjustment provides for the making of bends of any degree within the limits of the capacity of the machine.

For ordinary work the feed is by means of the friction rollers in the head of the machine, but if extra heavy pipe is being handled, or pipe which taxes the ca-

pacity of the machine, it is always advisable to have a positive feed for the pipe in addition to the friction feed of the rollers. This is accomplished by means of the endless chain seen in Fig. on its upper end and best seen in Fig. 3. From this worm drives a worm wheel; on the other end of its shaft is the driving sprocket for the endless chain before mentioned. If necessary the operator by moving the hand wheel above the worm can throw the clutch into engagement and thereby start the endless chain in motion. This chain carries dogs that can be engaged with the end of the pipe that is being bent, thereby providing a positive feed.

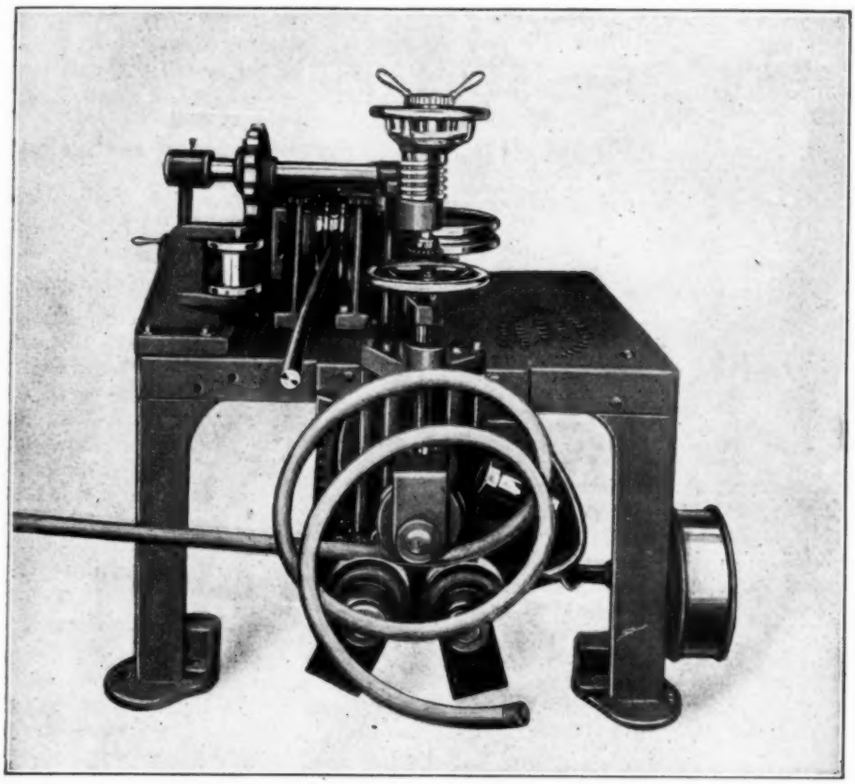


FIG. 4. MAKING A HELICAL COIL ON THE COX PIPE-BENDING MACHINE

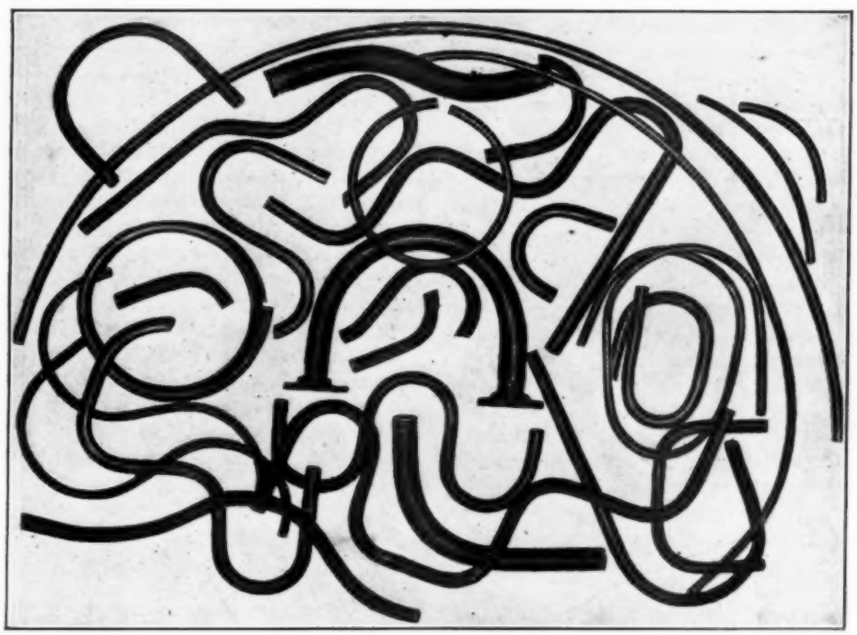


FIG. 5. BENDS MADE ON COX PIPE-BENDING MACHINE

1. A bevel gear, outside of the worm wheel beneath the machine, meshes with a bevel pinion on the end of the vertical shaft, having a worm and friction clutch

ATTACHMENTS

The machine can be provided with various attachments, such as one for producing conical helical coils (see Fig. 4.) Magazine attachments can also be provided for handling large numbers of pieces of pipe that are to be bent to the same shape and size. By the addition of this magazine attachment and its connecting mechanism the machine is automatic in its action. Fig. 5 shows a collection of pieces of pipe including four-inch boiler tubes, that have been bent to a variety of shapes by this machine.

Mechanical Draftsman

The United States Civil Service Commission announces an examination on January 26, 27 and 28, 1910, to secure eligibles for filling a vacancy in the position of senior mechanical and optical draftsman at the Frankford Arsenal, Philadelphia, Penn. Information regarding the examination may be obtained upon application to the United States Civil Service Commission, Washington, D. C.

Johnny Had a Little Dog

Johnny had a little dog,
Its tail was bent you know
And every piece that Johnny turned
That dog just had to go.

He used it one day on a bar
Of eighty carbon steel,
Which made the old lathe grind and groan
And caused the dog to squeal.

"What ails that dog?" the 'prentice said,
"What makes it groan and wail?"
"Why can't you see?" the old man said,
"It's swinging by its tail."

Test of Lubricating Oils

In a paper read before the American Society for Testing Materials, Robert Job describes a simple test of the value of lubricating oils under service conditions. He found that when heated to a temperature of 450 degrees Fahrenheit the oils which had given bad results showed a very marked darkening of color, while those which had proved satisfactory showed very little change. Another experimenter, E. Camerman, of the Belgian State railway, has devised a test of oils for lubricating engine cylinders. By heating the oil to 400 degrees Fahrenheit for six hours it is possible to determine the percentage of oil available for lubrication after allowing for that which escapes with the steam. This varies from a very low figure to as much as 60 per cent.

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January 6..... 41,250

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None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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A regular reading of the weekly AMERICAN MACHINIST is a post graduate course for the graduate of any tech., for any mechanic, for any manufacturer of machinery.

Those who do not see it must grope around in the dark or spend ten times as much money and hours to keep as well posted as a reader.

We shall be alert, we have the experience, the equipment and the men—abroad and at home—to make a good paper, better than we ever have made, and we have the disposition to do so.

The greatest asset we have, however, and they are as precious as fine gold, are many thousands of satisfied subscribers who encourage and help us, and to these we send our best wishes for 1910, for verily they are the backbone, the incentive and the conscience of this publication.

How To Get Apprentice Boys

The story of the apprentice school of the General Electric Company, told in other columns, can scarcely fail to attract the attention of those manufacturers who want, but cannot get, apprentice boys.

The extent of the works of the General Electric Company will cause many to dismiss the plan so far as its home application is concerned under the belief that it is not feasible in smaller works. Before doing this, however, the question should be asked and answered, what is the real secret of the success of these schools in attracting boys? That is, just what has Mr. Alexander done in order to bring about a successful apprenticeship system?

The answer is easy. What has been done is simply to provide for the deliberate teaching of the things which a mechanic should know, and we believe that this is all that it is necessary to do in order to duplicate the success of the West Lynn and the Schenectady schools in other shops.

We have before now expressed in these columns the opinion that the real reason for the decay of the apprenticeship system lies in the fact that the teaching function has disappeared. In the old and halcyon days of apprenticeship, which have been so often described, the intimate association of the apprentice with his employer insured a reasonably adequate amount of actual teaching, but with the development of the corporation as an employer this has disappeared.

To the apprentice the representative of the corporation for which he works is the foreman, who is employed in order to see that the work is gotten out, and who is judged in accordance with his success in getting it out. We need not enlarge upon the impossibility of any real teaching on the part of the foreman, the significant fact being that the teaching which the apprentice formerly received he receives no longer, and it is right here that the essence of Mr. Alexander's plan lies. He has revived this teaching function, and in doing so he has readapted the time-tried and proved apprentice system to the conditions of modern industry.

The significant fact is that when this is done and something is offered which the boys and their parents feel is worth while, the difficulty of obtaining apprentices vanishes. There could be no more eloquent testimony to this fact than the growth of the floor area devoted to this purpose at West Lynn from 1500 to 17,000—soon to be 24,000—square feet in seven years.

These schools are not the only ones that supply similar testimony. Professor Schneider's system of coöperative education is not a perfect parallel because, as applied by him, the students are given an engineering and not a trade education, but nevertheless in a broad sense it does demonstrate the same fact that there is an enormous demand for vocational training, combined with an opportunity to earn enough money for at least partial self-support. The most remarkable single feature of Professor Schneider's experience is the manner in which applicants for the work seem to spring from the very ground.

A strictly parallel case is, however, supplied by the adoption of the coöperative plan in Fitchburg, applied, however, to trade and not to engineering training. The plans of the Fitchburg enterprise restrict—in our opinion, unwisely—the eligibles to those boys who have com pleted a year of the regular high-school course. This restriction has so far made large numbers impossible, but the percentage test remains by which to judge of the popularity of the work offered, and it is a simple fact that at the beginning of the present year over one-third of all the eligibles in Fitchburg applied for admission to the shops as apprentices under this coöperative plan. Professor Sweet's artisan school, in Syracuse, supplies another illustration, his waiting list duplicating in numbers the pupils at work in the school.

Some may object that these experiences are not yet sufficient, either in number or age, to justify an absolute conclusion, but they are undeniably sufficient to justify a strong opinion that the combination of good teaching, with an opportunity to earn at least partial self-support, will solve the problem of getting apprentices.

A Better Way of Spending Twenty Million Dollars

Some of the statistics presented by those who are interested in the prevention of industrial accidents are startling in the extreme and indicate either a failure to grasp the situation with a broad-minded intent to work for better conditions, or a heartless disregard for the employee. We believe the former to be the true explanation, as we all know that there is a real bond of sympathy in most cases.

Probably the professional politician can be blamed for much of the wrong in present conditions, in the shape of unjust laws regarding industrial accidents. A suit for damages always leaves bad feelings in place of the mutual interest and sympathy that should exist, while the successful claimant only averages $400, half of which goes to his lawyer as a rule.

Instead of this, or of ever letting such cases come to trial at all, would it not be better to use the "defense" money to pay premiums on insurance policies for the men? That this would go a long way in this direction can be seen when we note that over $20,000,000 a year are paid to protect employers against law suits in negligence cases.

It must be remembered, however, that the case is not all one sided and that present conditions are largely due to fault on both sides. There is no need to point out just how and where, it is enough to say that the result has been unsatisfactory to both sides and that the time is ripe for improved conditions.

An example of some of the contradictions which incite ill feeling and make the workman feel that he is not fairly treated is shown in a recent case where the jury found "the deceased came to his death owing to his own carelessness," but ordered the employer to erect a guard around the pit to prevent anyone else being killed.

If every pedestrian and driver was careful enough, we would not require gates at railroad crossings, yet we insist on having them in most places and the railroad is responsible for all accidents when they are not down for any cause. In the same way we must protect against carelessness to a large extent and realize that if men stopped to be really careful, many operations would be much more costly than at present. If a laborer must be careful in avoiding an open hatchway, he cannot handle work around it as quickly as though it were carefully guarded so he need give it no thought. Then, too, it should be remembered that a well equipped factory, where conditions are good and accidents are few, will have the pick of the best men and will be on a sounder basis for continued prosperity than shops of the other kind.

A little careful thought along these lines will show that the subject is well worth careful and constant consideration.

Another Way in Which Writing Paid

Several months ago we printed numerous letters describing experiences of our contributors in writing for the technical press. Another incident of this nature has just reached our attention and one that is worthy of comment.

A certain organization was looking for a manager. The president of the board of directors at length picked his man, and undertook the somewhat delicate task of setting the tide of opinions of the other members of the board in his direction. One exhibit that was made use of—if exhibit it can be called—was a scrap book containing articles contributed by the candidate to the technical press and, as it happened, largely to our columns. This scrap book was prepared under the direction of the president of the board, and he showed it to his associates with the statements that a man thinks and talks as he writes and shows in his writings what he is and to quite an extent what he can do.

The president's candidate was at length elected, and is successfully filling the position. The real extent of the effect of the scrap book is, of course, unknown, but the articles it contained were an index of the technical ability and viewpoint of their author, at least as regards the subjects treated. That such writing may be of real value to a man is shown by the action of the president in arranging the material in a shape to show his colleagues, knowing that it would have nothing but a beneficial effect. Thus previous writing for the technical press aided this man directly in getting a desired position.

Personals*

Frederic H. Keyes, formerly general manager of the Robb-Mumford Boiler Company, has associated himself with Messrs. Timothy W. Sprague, Henry Docker Jackson, and others, for the purpose of conducting a general consulting engineering practice in New York City.

W. J. Best, for the past three years engineer and sales manager of the Chicago office of the Buckeye Engine Company, has recently accepted a position with the Wheeler Condenser and Engineering Company, with whom he will act as treasurer as well as taking part in some of the engineering work.

*Items for this column are solicited.

NEW TOOLS and MACHINE SHOP APPLIANCES

Showing New Ideas in Machine Shop Equipment that make it possible to do better work at a reduced cost

The Tabor Shockless Jarring Machine

Jarring machines seem to have been growing in favor for the past few years, although it is probably safe to say that ten years ago no one would have thought of a jarring machine for molds any larger than those used on a power squeezer which one or two men could handle. It has since been found that large molds can be rammed as readily as small ones and today it is not uncommon to hear of jarring machines capable of ramming molds weighing 10 to 20 tons. But with this increase in capacity has come the very serious complaint of damage due to foundation shocks when such heavy masses fall upon their anvil. These shocks are destructive to molds set up in the neighborhood of the machine and the ground waves sometimes travel far enough to cause serious annoyance in other departments of a manufacturing plant.

The present machine has been designed to eliminate the foundation shocks and to be used in any position and under any conditions where an ordinary power squeezer would be practicable, such as in brass foundries on the upper floors of high buildings strong enough to carry its weight.

Fig. 1 shows the machine set in a pit with linkage connecting the operating valve on the machine to the operating levers as conveniently arranged near the jarring table. Fig. 2 shows the jarring table, the anvil cylinder and a simpler arrangement of connections to the operating valve than that shown in Fig. 1.

Fig. 3 shows the bell cranks controlling the variable stroke of the jarring table and the automatic cutoff of the differential piston valve, which is operated by constant and intermittent pressure through the pilot valve, shown connected by link to bell crank in front. The position of stop which controls length of stroke is designated by an arrow, and is shown in its minimum and maximum positions.

The machine consists of a jarring table made in one piece with the cylinder and mounted upon a cylindrical anvil, which in turn is guided by a cylindrical base and rests upon supporting springs calculated to give the anvil a substantial upward velocity while the table is falling. The supporting springs beneath the anvil carry the entire load of anvil, table and mold under static conditions and also while the table is rising, but when the table reaches the upward limit of its travel, and when the air is exhausted to let it drop, the anvil is suddenly relieved of the air pressure, which supported the table, and as a natural result the springs beneath the anvil expand and accelerate its upward movement while the table is falling. As a result, the momentum of the falling table and load is substantially equal to the momentum of the rising anvil at the instant of impact, neutralizing each other, and bringing the table to rest without shock or jar upon any surrounding objects. In order to do this the springs beneath the anvil have a very long compression, so that their loss in supporting power, as the anvil rises, will not materially affect its velocity.

Ordinarily, the springs are sufficient to give the desired momentum to the anvil, but in large machines, where the consumption of air is an important item, the air discharged from the jarring cylinder is utilized in augmenting the momentum. This is done by making an additional port in the operating valve which connects the jarring cylinder and anvil cylinder while the table is falling. When the operating valve is again shifted to lift the table, the valve is opened to exhaust and the anvil is, therefore, free to drop. The operating valve is designed to use it expansively in the jarring cylinder as well as to expand it again in the anvil cylinder, thus obtaining the benefit of two expansions. This is not possible in the jarring cylinder when the load carried on the table aproaches the maximum capacity of the machine, but on lighter loads, full air pressure can be admitted for a short distance and then expanded in the cylinder.

When the table reaches its maximum travel, the operating valve is automatically shifted to exhaust, and the air from it may pass directly into the atmosphere, or into the anvil cylinder, if the machine is large enough to make a second expansion worth while. The cutoff is operated directly through the bell-crank lever acting as an adjustable stop upon an arm attached to the valve stem. The valve is reversed through the action of a pilot valve actuated by a similar bell-crank lever. There are, therefore, two adjustable stops on the table of the machine, the positions of which are controlled by latch levers on an operating stand. The cutoff can be adjusted to suit the load carried on the table, and the operating valve can be reversed by the pilot valve when the maximum uplift desired has been reached.

Compressed air can be substituted for the supporting springs under the anvil in the simpler type of machine, where no attempt is made to use air expansively from the jarring cylinder to the anvil cylinder, but this necessitates some pro-

Concerning Illustrations of New Tools

Owing to the great extension of the circulation of the AMERICAN MACHINIST *we can no longer afford to compete for matter for this department with other papers.*

1—Every illustration and description of a new tool or machine-shop appliance appears in the Weekly, Monthly, English Weekly and German Weekly ("Maschinenbau") editions—four separate publications.

2—Notable, new or improved tools are sometimes described in the body of the paper, or given larger cuts and longer descriptions in this department, but only when the manufacturer agrees to give us the opportunity to bring it out ahead of all other papers and promises not to send it to other papers until after it appears in the AMERICAN MACHINIST.

3—Descriptions and illustrations received under any other circumstances will be treated as news with brief descriptions and, generally, single-column cuts.

The fact that we place such descriptions in the hands of the responsible men of more machine shops than all other papers in the world combined, makes this rule necessary.

The news? Yes. Because it is news. But the leaders to those who help us get the news first.

We invite frankness concerning matter for this department. It is for you to decide whether you want it featured in these four papers or in others. Send it either way, but write us saying whether it is for us first, or if you have, or will send it to other papers before we publish it.

vision for keeping pressure adjusted to the total load carried, without causing undue variation in the hight of the jarring table, as it is more or less loaded, and as air may leak in or out.

The effect of impact between the table and anvil in jar ramming is measured by the change in velocity of the table, and the square of this change in velocity is proportional to the work done upon the sand for any assumed condition of the sand. A short stroke indefinitely repeated will ram sand up to a certain density, but very hard ramming such as is frequently required in steel foundries, can only be effected by a considerable length of stroke, so a variation of stroke from 1 to 4 inches has been provided.

Parts exposed to wear are amply protected by sand guards and provision is made for the renewal of such bearings as may become worn. Although very little sand can find its way into the pit during the normal operation of the machine, the accumulation of sand in the pit cannot affect the operation of the machine until it has attained great depth.

The small machine of this type, weighing about three tons, which has been built and tested, demonstrates that no shock is perceptible on the foundation. This machine was mounted upon two 8-inch channel beams in a pit about 10 feet wide, the beams resting upon the sides of the pit and the machine in the middle of the beams. A man standing on these beams, while the machine was running, could not detect any vibration whatever, and although there was necessarily a slight change of load as the table rose and fell, the effect on the floor beams was no greater than it would be for an ordinary power squeezer operating in the usual way.

It is believed to prevent the tremulous waves which are destructive to floor work and molds set in the neighborhood of the machine, or even at some distance.

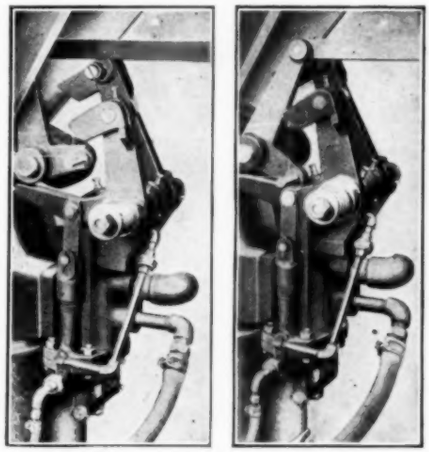
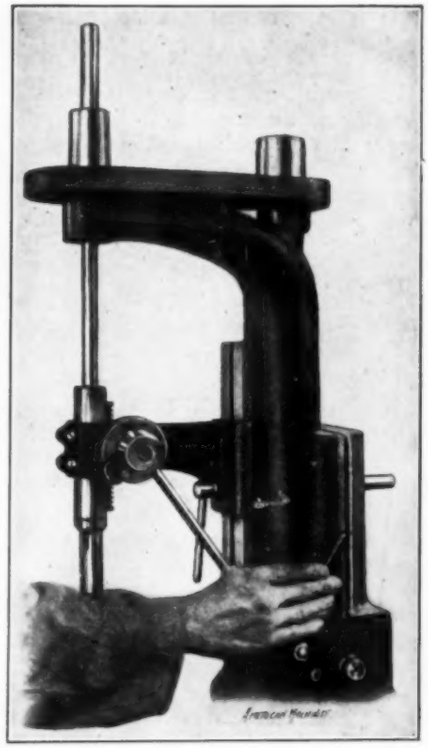


FIG. 3. DETAILS OF THE VALVE GEAR



A CONVENIENT TAPPING ATTACHMENT

Convenient and Efficient Tapping Attachment

The illustration shows a very convenient tapping device recently brought out by the Taylor-Fenn Company, Hartford, Conn. The device is inclosed in the bottom of the column, a small projecting lever throwing a clutch into either a forward or backward motion by an ingenious arrangement of bevel gears inside the column. Power is disengaged when the

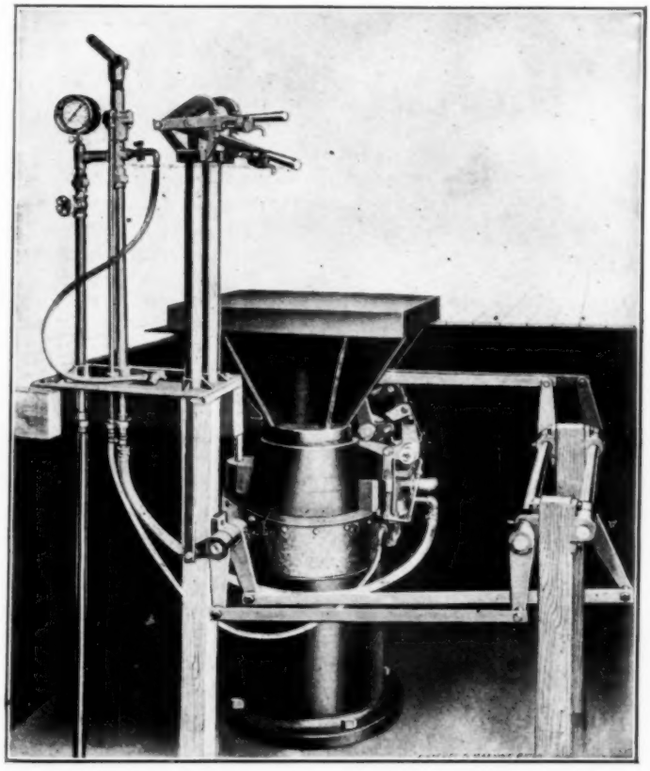


FIG. 1. THE TABOR SHOCKLESS JARRING MACHINE

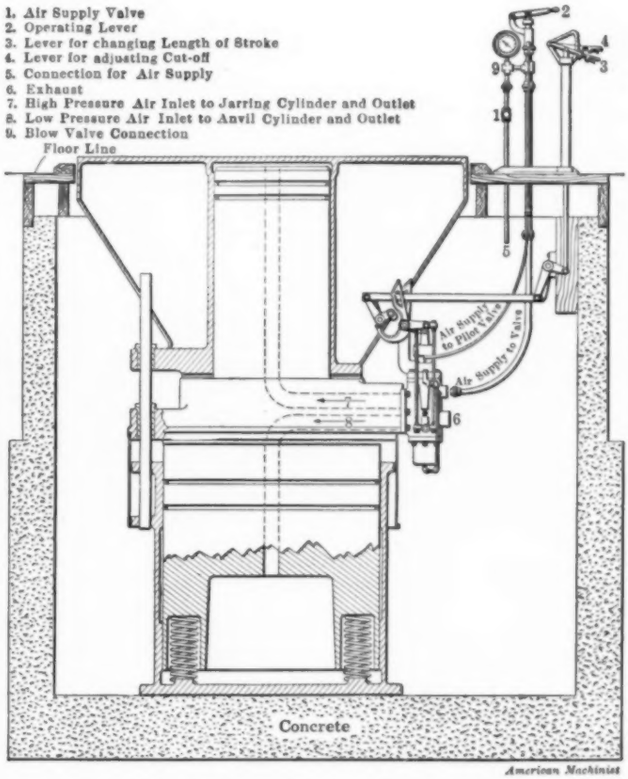

1. Air Supply Valve
2. Operating Lever
3. Lever for changing Length of Stroke
4. Lever for adjusting Cut-off
5. Connection for Air Supply
6. Exhaust
7. High Pressure Air Inlet to Jarring Cylinder and Outlet
8. Low Pressure Air Inlet to Anvil Cylinder and Outlet
9. Blow Valve Connection
Floor Line
Air Supply to Pilot Valve
Air Supply to Valve
Concrete
American Machinist

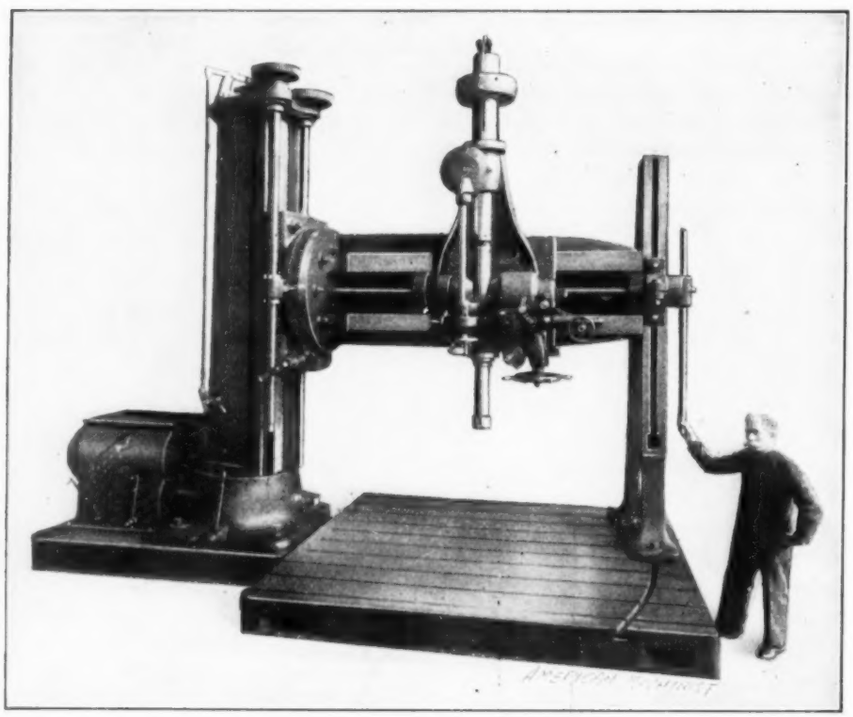
FIG. 2. DIAGRAM OF MACHINE AND CONNECTIONS

lever is in a central position, which is very convenient for stopping the spindle in changing taps.

The same hand that feeds the spindle down grasps the reversing lever when the proper point is reached, and can instantly throw the clutch so as to engage in the opposite direction. The position of the feeding lever can be readily adjusted so as to bring the hand convenient to the reversing lever, as both the quill and the table are movable. When desired they also make a positive connection between the two levers, although the hand reversal is usually considered most desirable.

New Belgian Radial Drill

The accompanying illustration shows a radial drill recently supplied to the firm of Thomas & Peslin, Anzin, France, by Ateliers Demoor, Brussels. The maximum radius of the drill is 2 meters 150 millimeters (84.64 inches), the minimum radius is 1 meter (39.37 inches), and the maximum hight under the spindle is 1 meter 800 millimeters (70.86 inches), while the vertical movement of the radial arm is 1 meter 300 millimeters (51.18 inches), and the vertical travel of the drill spindle is 400 millimeters (15.75 inches). It will be seen that the bed is slotted for securing jobs and also that a circular groove is cut in it from the end stay to the arm. The drive is by means of a single pulley and gear box with sliding gears controlled by levers. In this way 18 speeds can be obtained on the spindle.

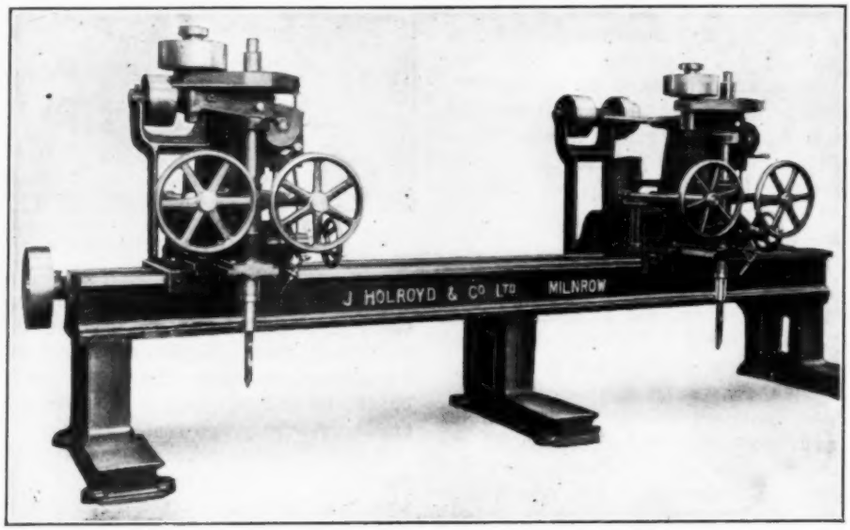


LARGE RADIAL DRILL FROM BELGIUM

The rotation of the arm in the horizontal plane is obtained by hand by means of the worm gear shown. When desired the drill-spindle carriage can be made so as to swivel the drill to almost any angle. Four feeds by gearing are given to the spindle, a friction clutch allowing instant engagement or release. Ball bearings are provided for the rotation of the arm and for the drill spindle. The space occupied by the foundation plate is stated to be 2 meters 600 millimeters by 2 meters 500 millimeters (102.36x98.42 inches), and the approximate weight of the machine is 9100 kilograms (say 20,020 pounds).

Channel Bar Drilling Machine

For drilling channel bars, girders, etc., as used by constructional engineers and also by railway carriage and wagon builders, the firm of J. Holroyd & Co., Ltd., Milnrow, near Rochdale, England, manufacture a double-head machine of the type here illustrated, which has been found in certain instances to displace the radial form of drill. The machine is made in three sizes, the type used by railway carriage and wagon builders being smaller, with the spindle belt-driven only and arranged to drill holes up to 1 inch in diameter, the machine shown drilling holes up to 2 inches in diameter. A still smaller machine is manufactured for drilling the frames of motor cars, etc.



DRILLING MACHINE FOR CHANNEL BARS

The machine has two special features, one the belt drive, and the other the manner in which each spindle can be adjusted to the positions of the various holes on girders, etc. This is managed by means of the two large handwheels seen in front of each drill headstock. The heads are moved in either direction by rack and pinion, one handwheel traversing the spindle along the bed, while the other gives motion at right angles. It is, of course, commonly found that the holes to be drilled are in lines at right angles. Therefore to move the spindle to a new position it is very often only necessary to make one adjustment, either along the bed or across it.

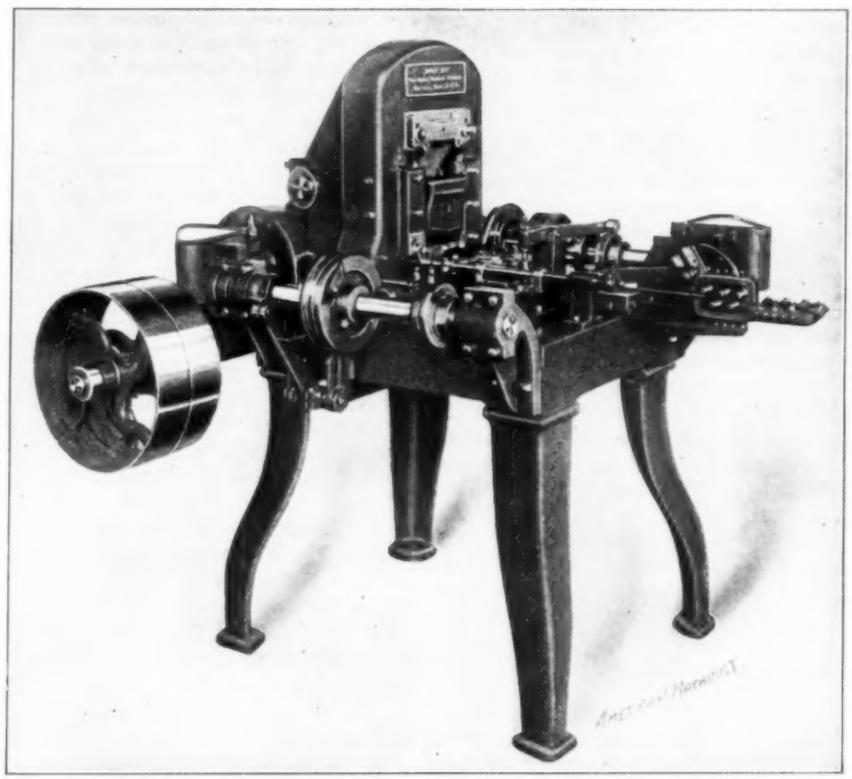
No gears are used except for holes larger than 1 inch in diameter. Each spindle is driven from a shaft at the back of the machine, this giving motion to the two-speed cone to be seen on one of the swinging brackets. The pulley at the other end of the cone shaft drives the spindle by means of a quarter-twist belt. The spindle has vertical, self-acting, down feed by means of a gear box with three

changes, and four spindle speeds are available on the machine as arranged. If desired the bed can be provided with a table for supporting the work.

Wire Forming and Stamping Machine

This machine automatically takes wire from the coil, straightens, feeds, cuts off, forms and stamps it into such articles as suspender and belt buckles, and other articles requiring the operations of forming and stamping. It finishes them complete, drops them into a suitable able receptacle at the rate of about 60 to 80 per minute, according to the size and shape, and requires no further attention than removing the finished article and keeping the machine supplied with wire.

It is at present built in two sizes, the smaller size making articles that do not consume more than 6 inches of wire, or larger than 0.125 inch in diameter, and the larger machine handling 9 inches of wire and up to a diameter of 0.200 inch. It is made by the Baird Machine Company, Oakville, Conn.



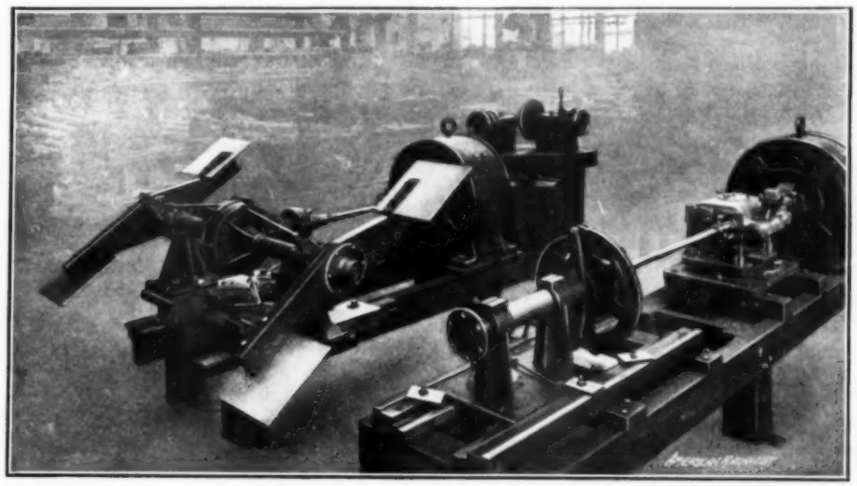
WIRE FORMING AND STAMPING MACHINE

The approximate value of the output of pig iron in the United States in 1908 (15,936,018 long tons) as reported by the producers to the United States Geological Survey, was $254,321,000, delivered at the furnaces. The average price per long ton was $15.96.

Testing Transmission Units

This shows a corner of the assembling department of the Pierce Arrow Motor Car Company, Buffalo, N. Y., which has been set aside for the testing of the geared units which go to make up the automobile. In the center and beyond the other machines is a Gleason bevel-gear tester for testing rear-axle transmission gears after they have been hardened. The pinion is driven by the pulley shown at the left and in this way a running test is readily secured.

The transmission gear boxes are set in at the right, being driven by the motor shown and the load applied by the brake at the end of the transmission shaft. In this way varying loads can be applied and the gear box tested in its various combinations so that they may know before assembling, that it runs quietly as it should.



TESTING TRANSMISSION AND REAR AXLE GEARING

At the left is the testing stand for the rear-axle transmission and a fan is attached to each end for applying the load in a similar manner to that used in testing out motors. These are guarded when in operation, the guard being removed to show the apparatus clearly.

In this way it is possible to know before the units are assembled that they do not make an unusual amount of noise, and this matter greatly reduces the cost of trying out cars after they are in the finished state.

Pressure in Rays of Light

That rays of light exert a pressure upon surfaces upon which they fall would call the average man's imagination actively into play in order to believe; still this question is one that has often been made the subject of interesting experiments which have gone to prove the certainty of the contention. Professor Poyntining, of the Birmingham University, contribues the latest information on this interesting topic, and in a lecture demonstrated by numerous experiments that pressure in light does exist. The most common method of measuring such pressure is by placing a silver glass disk in a vacuum and then permitting light to strike it, measuring the pressure thus exerted on the disk by highly sensitized apparatus. In the paper read by Professor Poyntining several methods were pointed out whereby the contention of light pressure was substantiated, and some of the proof cited seemed conclusive.

A Factory Mutual Benefit Association

By F. C. Mason

From time to time I have seen articles in your valuable paper describing the workings and benefits of these associations in other institutions. Our association (of the Bissell Carpet Sweeper Company) has been in existence for 20 years or more, and the benefits are in excess of most such associations.

It was founded by M. R. Bissell, the founder of the company bearing his name. Mr. Bissell organized and endowed the association with $1000, and there is an understanding that if by any large death rate, caused by accident or other cause, to suddenly deplete the treasury, the company will come forward with enough to compensate.

The membership is not compulsory, but we have the majority of employees. After running for 20 years our annual statement shows a balance of nearly $1000 and the association has always done more than the original constitution calls for.

The monthly dues in class A are 25 cents a month; in class B 50 cents per month. Nearly every year the dues for one or two months have been remitted, as we only aim to keep $1000 in the treasury.

Constitution of the Mutual Benefit Association of the Employees of the Bissell Carpet Sweeper Company

ARTICLE I

Section 1. This society shall be known as the Mutual Benefit Association of the Employees of the Bissell Carpet Sweeper Company, and shall consist of two classes —Class A and Class B.

ARTICLE II—OBJECTS

Sec. 1. The objects of this Association are, to aid its members in case of sickness, disability or death, and to provide a fund from which such sums shall be paid as the by-laws may direct.

ARTICLE III—MEMBERSHIP

Sec. 1. All members of this Association must be employees of the Bissell Carpet Sweeper Company, and of good moral character.

ARTICLE IV—OFFICERS

Sec. 1. The officers of this Association shall consist of a President, Vice-President, Secretary, Treasurer and Board of Trustees, thirteen in number.

ARTICLE V—ELECTION OF OFFICERS

Sec. 1. The officers of this Association shall be elected annually by ballot at the regular annual meeting, the second Saturday in March, and enter upon their duties at the next regular meeting.

ARTICLE VI—DUTIES OF OFFICERS

Sec. 1. It shall be the duty of the President to preside at all meetings of the Association, to appoint all committees, sign all money orders, enforce due observance of the by-laws, and see that other officers properly perform the duties assigned them, and to generally exercise a careful supervision over the affairs of the Association.

Sec. 2. It shall be the duty of the Vice-President to assist the President, and in his absence to perform the duties of his office.

Sec. 3. It shall be the duty of the Secretary to keep true and impartial minutes of meetings and conduct all correspondence; to collect assessments from members, giving a receipt therefor, and pay all moneys to the Treasurer, taking his receipt for the same, and sign all money orders, and to make monthly reports of receipts and disbursements, and amount of cash on hand.

Sec. 4. The Treasurer shall hold the funds, vouchers, securities and other property of the Association subject to the action of the Board of Trustees. He shall pay all orders drawn by the Secretary and approved by the President. He shall render an account in writing to the Association at its annual meeting in March of its finances, which account shall be referred to an auditing committee, appointed by the President.

Sec. 5. It shall be the duty of the Board of Trustees to act upon all applications for membership, to order such investment of money from time to time, as a two-thirds majority of all members present at a regular meeting, acting under the by-laws, may direct.

ARTICLE VII

Sec. 1. This Constitution may be amended by a two-thirds vote of members present at any regular meeting, provided that a notice in writing has been given of such intention at a previous regular meeting.

By-Laws

ARTICLE I—MEETINGS

Section 1. The regular meetings of the Association shall be held in the office of the Bissell Carpet Sweeper Company on the second Monday of each month at 5 p.m.

ARTICLE II—APPLICATION FOR MEMBERSHIP

Sec. 1. All applications for membership must be made to the President, who shall lay the same before the Board of Trustees for action. A majority shall be necessary to an election.

ARTICLE III—CLASSES

Sec. 1. Class A shall be composed of all persons in the employ of the Company, male or female, who are members of this association regardless of the amount of their weekly compensation.

Sec. 2. In case of sickness in this class from any cause, upon recommendation of the Sick Committee indorsed by the President and allowed by the Board of Trustees, an order shall immediately be drawn by the Secretary on the Treasurer for the full amount of wages the sick member would have received up to and including three dollars and fifty cents per week, but in no case shall they receive more than this amount.

Sec. 3. In case of accident in this class while the member is engaged in discharging his or her duty in the service of the Company, upon recommendation of the Sick Committee indorsed by the President and allowed by the Board of Trustees, an order shall immediately be drawn by the Secretary on the Treasurer for the full amount of wages they would have received up to and including eight dollars per week, but in no case shall they receive more than this amount.

Sec. 4. In case of death of a member of Class A from accident in discharge of duty or from sickness, upon recommendation of the Board of Trustees, indorsed by the President and Secretary, an order shall immediately be drawn in favor of the family or legatees of the deceased member of the amount of $150.00. Benefits in case of sickness shall not extend over a period of thirteen weeks in any one year unless by a special vote of two-thirds of the Board of Trustees. Benefits in case of accident not to exceed twenty-six weeks, unless by a two-thirds vote of the Board of Trustees.

Sec. 3. Class B shall be composed of members of this Association whose weekly wages equal eight dollars or upward. In case of sickness in this class, from any cause, upon recommendation of the Sick Committee, indorsed by the President and allowed by the Board of Trustees, an order shall immediately be drawn by the Secretary on the Treasurer at the rate of six dollars per week for all full weeks, but in no case shall the compensation be greater than six dollars per week.

Sec. 6. In case of accident in this class while the member is engaged in discharging his or her duty in the service of

the Company, upon recommendation of the visiting Committee, indorsed by the President and allowed by the Board of Trustees, an order shall immediately be drawn by the Secretary on the Treasurer for the full amount of wages they would have received up to and including twelve dollars per week, but in no case shall they receive more than this amount.

Sec. 7. In case of death of a member in Class B, from accident in discharge of duty or from sickness, upon recommendation of the Board of Trustees, indorsed by the President and Secretary, an order shall be immediately drawn in favor of the family or legatees of the deceased member for the sum of $300.00.

All members of this Society, who may receive any injury to his limbs, or become sick so as to incapacitate him from attending to business, shall receive sick benefits, as provided by the By-Laws, for a period not to exceed thirteen weeks, unless in special cases, which will require the sanction of two-thirds of the Board of Trustees, but in no case shall sick benefits extend beyond a period of twenty-six weeks. Refusal on the part of the Board of Trustees to extend sick benefits, cancels the membership in the Society of the applicant for relief, both as to sick and death benefits.

Sec. 8. Members of Class A can become members of Class B according to the provisions of Section 5 of these By-Laws, but in no case can any person be a member of more than one class at the same time.

ARTICLE IV—ASSESSMENTS

Sec. 1. The regular assessments of Class A shall be twenty-five cents per month, and shall be paid to the Secretary direct on the first pay day of each month.

Sec. 2. Regular assessments of Class B shall be fifty cents each per month, and shall be paid to the Secretary direct on the first pay day of each month.

ARTICLE V—FORFEITURE OF MEMBERSHIP

Sec. 1. Any person belonging to either Class A or Class B leaving the Company's employ, either voluntary or by dismissal, shall, on such date, no longer be a member of the Association, but in no instance shall this clause be construed to interfere with any rights or benefits to which a member may be entitled under the provisions of this Constitution and By-Laws at the time of such separation.

ARTICLE VI—RIGHT OF DISMISSAL BY COMPANY

Sec. 1. No clause of these By-Laws shall be construed to interfere with the free and uninterrupted right of the Bissell Carpet Sweeper Company in making such dismissals or changes in the working force as the necessities of the business may demand, and any member dismissed for any cause cannot consider his removal an injustice on the part of the Company, because during the time that he was a member of the Association in good standing he was entitled to full measure of protection.

ARTICLE VII—MEMBERS IN ARREARS

Sec. 1. Any member in arrears at the time of the regular monthly meeting of the Board of Trustees, must be reported by the Secretary, and the Board shall suspend such member from benefit, until they shall have paid their indebtedness. The Secretary shall notify any member thus suspended. The failure of any member to pay their indebtedness within ten days of such notice cancels their membership in the Society.

Sec. 2. After a member has been notified that his membership with the Association has expired, he shall not be entitled to nor shall he receive any benefits from the Association until such time as he has been reinstated.

ARTICLE VIII—BENEFITS

Sec. 1. To be entitled to benefits in this Association a member who shall become sick or disabled, incapacitating him from attending to his duties, must immediately notify the President of such sickness or disability.

Sec. 2. Benefits shall begin with the date the President's notification of said sickness or disability, and continue until such sickness or disability has ceased, or until, in the opinion of the Sick and Visiting Committee, he is no longer entitled to relief. This section is not designed to interfere with the provisions as set forth in Article III, sections number 2, 3, 4, 5, 6 and 7 of these By-Laws.

ARTICLE IX—DISABILITIES AND PENALTIES

Sec. 1. Any member of the Association who may be disabled by dissipation or immoral conduct, or by undue carelessness, such as wrestling, fighting or by hazardous exercise, shall not be entitled to benefits or relief.

Sec. 2. Members wilfully imposing upon this Association by claiming or receiving relief when not legally entitled to the same, shall be expelled from the Association, and they shall under no condition be admitted to membership again.

ARTICLE X—COMMITTEES AND THEIR DUTIES

Sec. 1. The Auditing Committee shall be composed of five members of the Association, with the President and Chairman *ex officio*, two members of the committee to be chosen from Class A and three from Class B. It shall be the duty of this committee to audit all accounts, and after their regular meeting in March each year to examine and compare the books of the Secretary and Treasurer before they are placed in the hands of the Secretary and Treasurer elect, and to report at the regular meeting of the Association in April.

Sec. 2. The Sick and Visiting Committee shall be composed of three members, with the President as Chairman *ex-officio*. The duties of this committee are to visit the sick and disabled members twice a week and make such reports to the President and Secretary of the Association as the condition of the sick or disabled members in their judgment may require, and to use diligence and caution in their office to prevent all unjust claims, and to see that all who are entitled to relief are properly reported.

Sec. 3. If anyone of the sick committee wilfully neglects his or her duty, there shall be a fine of $1.00 imposed upon them, and if they do not pay the same within thirty days he or she shall not be entitled to any benefit on and after that date until such fine be paid.

ARTICLE XI—NAMING BENEFICIARY

Sec. 1. It shall be the duty of each member to file with the Secretary a statement in writing setting forth the name and address of persons who they desire to become their beneficiary in case of death, and such statement will be considered to exist in full force until by special request of the member the same is withdrawn or changed, which notice of change or withdrawal will also have to be in writing; and it shall be the duty of the Secretary to provide a book in which the name of each member, with name and address of beneficiary, shall be recorded.

ARTICLE XII—HOW FUNDS SHALL BE DEPOSITED

Sec. 1. It shall be the duty of the Treasurer immediately upon receipt of any moneys belonging to the Association to deposit the same in some bank of deposit, to be named by the Board of Trustees, and in no instance keep funds of the Association in his possession longer than twenty-four hours before depositing the same.

Sec. 2. The Treasurer shall pay all bills, claims and accounts against the Association by check, which check must be signed by him as Treasurer of the Association, and be countersigned by the President.

ARTICLE XIII—BONDS OF OFFICERS

Sec. 1. The Treasurer shall be required to give a bond to the Association with two approved sureties, to guarantee the faithful performance of his duty. The amount of the bond shall be $300.00.

Sec. 2. The Secretary shall be required to give a bond to the Association, with two approved sureties, in the amount of $50.00 as a guarantee of faithful performance of duty.

ARTICLE XIV—QUORUM

Sec. 1. Seven members in good standing shall constitute a quorum for the election of officers, etc., but in all matters which legally come before the Board of Trustees, a majority of said Board shall be necessary for a quorum.

ARTICLE XV—AMENDMENTS

Sec. 1. These By-Laws may be amended by a two-thirds majority of all members present and voting at a regular meeting, provided that notice of such amendment has been presented at a previous regular meeting.

ORDER OF BUSINESS

1. Calling the roll of officers.
2. Reading the minutes of previous meetings.
3. Reports of officers.
4. Reports of Standing Committees.
5. Reports of Special Committees.
6. Communications and Bills.
7. Unfinished Business.
8. New Business.
9. Miscellaneous Business.
10. Application for Membership.

A Handy Milling Fixture

BY MILLS WRIGHT

We very often see a jig or fixture for finishing a boss, or taking a light cut that is so complicated that it requires more time to clamp the piece in place than it does to do the real work on the piece. This is particularly true with such work as adding-machine and typewriter parts.

The drawing shows a quick-acting fixture operated by a single lever. The part to be milled, Fig. 1, is white metal and the cut is light. The first operation is to finish the bottom of the piece; the fixture for this is very simple and ten are finished at a time on a planer.

FIG. 1. The Work

The second operation, for which the fixture in Fig. 2 is designed, is milling the upper side to take a rack; and the cut must come as near the middle of the piece as it can, considering that only one surface is finished and that the inside surfaces of the two hubs must be finished an equal distance from the center line of the piece.

This fixture is very simple, having but one lever or cam to set. On the base *A* is mounted a simple clamp *B* and the cam lever *C*. When the cam is released the spring *D* forces the clamp open, allowing the finished piece to be taken out and a new one put in against the backing plate *E* which is screwed to the base.

On the clamp end of the base are located two centralizing jaws *F*, pivoted on studs *G*. In the lower end of the clamp *B* are counterbored a ½-inch hole and a ¼ 20-tapped hole as shown in the sectional plan. In the base is a ½-inch reamed hole and a ⅝-inch counterbored hole in which slides the tapering piece *H*. A ¼-inch hole is reamed in *H* through which the adjusting screw *K* is put. Two tool-steel plungers *L*, with one end to suit the taper of *H* bearing against the two centralizing jaws *F* and the spring *M* pushing against *B* and *H*, close *F F*, locating the work centrally on the fixture. *N N* are stop pins for jaws *F*.

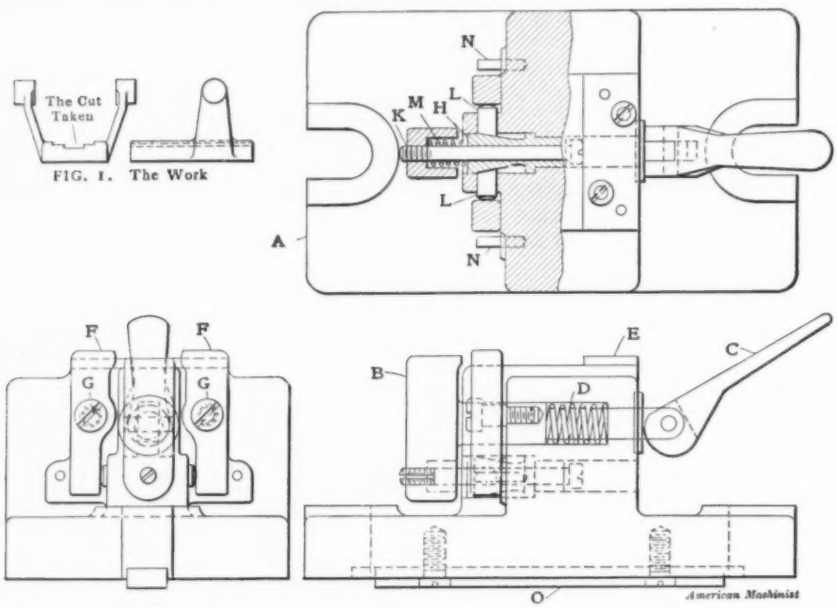


FIG. 2. MILLING FIXTURE WITH QUICK ACTING CLAMP

The screw *K* is slotted the entire length of the threaded portion and then spread so that it will not get loose and jar out. The head of the screw is also slotted and should be used when adjusting instead of the threaded end.

Considerable thought should be given to the design of *K*, even more than one might suppose at first glance. It should be so that when the spring *D* has forced the clamp *B* wide open, piece *H* will also move, allowing the jaws *F* to be free to move. It should also be designed so that before *B* starts to clamp the piece, *H* will be under the tension of spring *M*, forcing the plungers *L* out against the jaws *F* and centralizing the piece.

O is a tongue that fits the slot in the milling-machine table.

Classification of Bolts and Nuts

BY R. W. RODGERS

The following methods of designating the sizes of bolts in three or more figures are very simple. No. 936 would mean a bolt 9/8 inch diameter and 36/8 or 4½ inches long; and No. 1248, a bolt 12/8 inch diameter and 48/8 inches long. This is one method but the following seems better: No. 904 means a bolt 9/8 inch diameter and 4x9/8 or 36/8 inches long. Similarly No. 1204 shows at a glance that the bolt is 12/8 inch diameter and 4x12/8 or 48/8 inches long.

Further to discriminate between round, square, hexagonal or conical head bolts prefix the letters R, S, H and C; thus No. R 708 would be a round-headed bolt ⅞ inch in diameter and 56/8 inches long.

The nuts are represented by adding two ciphers to the diameter figure; thus H 900 and R 1200 represent respectively a hexagonal nut 9/8 inch diameter and a round-headed nut 12/8 inch diameter. I suggest using ⅛ inch as the unit, this being practical in shop work, but any other unit such as 1/32 inch could be used.

A table of inch bolts would appear as follows:

808, 816, 824, 832, 840, 848, 856;

or

801, 802, 803, 804, 805, 806, 807;

the nut being 800.

The second method is better as it practically eliminates a repetition of figures for different size bolts. In storing bolts, each shelf is numbered, as outlined above and the bolts stored accordingly.

There have been many attempts to solve the secret of perpetual motion. The nearest approach to that ideal—though its inventor makes no claim to have discovered it—is a timepiece devised by the Hon. R. J. Strutt, Lord Rayleigh's son, which consists of two leaves of aluminum, an exhausted glass tube, and a fraction of a grain of radium. The radioactivity of the radium causes the aluminum leaves to move once a minute, and with a wireless coherer a bell rings at each movement. For 10,000 years at least the wonderful energy inherent in the microscopic piece of radium will, it is calculated, continue to act.

INCREASING · SHOP · CAPACITIES

where More Tools will be needed

The Corliss (Wis.) Auto Company will erect a new plant.

Keene Canning Company, Freeport, Ill., is erecting a new plant.

The Washington Foundry, St. Paul, Minn., will build an addition.

The Royal Linen Mill, Mystic, Conn., is putting up its first mill.

The Buffalo (N. Y.) Brewing Company is erecting a new brewery.

The Worcester (Mass.) Pressed Steel Company will erect a new building.

F. H. Davis, Cambridge, Mass., will build an addition to its machine shop.

The Anderson Vehicle Company, Fond du Lac, Wis., will enlarge its plant.

The Erie Railroad will spend $150,000 in remodeling its shops at Kent, Ohio.

M. L. Andrews & Co., Cincinnati, Ohio, will erect a two-story machine shop.

The Bradley Stencil Machine Company, St. Louis, Mo., will build a new factory.

The Strong Steel Foundry Company, Buffalo, N. Y., will enlarge its foundry.

The Garry Iron and Steel Company, Cleveland, Ohio, will move to Youngstown.

A plant for the Pittsburg Bolt and Screw Company will be erected at Gary, Ind.

The American Hoist and Derrick Company will build a machine shop at St. Paul, Minn.

The Goodyear Tire and Rubber Company, Akron, Ohio, will build a five-story addition.

The roundhouse of the Rutland Railroad at Alburg, Vt., was burned. Loss, about $100,000.

The Keeler Brass Company, Grand Rapids, Mich., will build an addition to its foundry.

A new building is being erected for the Wm. I. Keetch Knitting Company, Cleveland, Ohio.

The Cadillac (Mich.) Machine Company has plans prepared for a new structural steel shop.

The Remington Safe Company, Philadelphia, Penn., is erecting an addition to its plant.

The Keystone Fiber Company, Chester, Penn., is having plans prepared for a new plant.

The Dahlstrom Metallic Door Company, Jamestown, N. Y., is erecting another addition.

Dorsey & Bone, Putnam, Conn., will need some woodworking tools for a new handle factory.

The Merson-Bacon Company, Bay City, Mich., is preparing plans for a new box factory.

The plant of the Woonsocket (R. I.) Wagon Manufacturing Company was burned. Loss, $15,000.

The E. H. H. Smith Silver Company, Bridgeport, Conn., will build a two-story addition.

The Pioneer Car Company, El Reno, Okla., will erect buildings for the manufacture of automobiles.

The Greystone Mills, North Providence, R. I., has let contract for additions to cost $400,000.

C. A. Dixon & Co., Newark, N. J., doing general machine work, will build an addition to their plant.

The cabinet factory of Jordan & Co., Brooklyn, N. Y., was burned, causing a loss of about $60,000.

The Snow Steam Pump Works, Buffalo, N. Y., is planning the addition of a new machine shop.

The W. L. Russell Box and Lumber Company, McKees Rocks, Penn., has bought site for a new plant.

The Henney Buggy Company, Freeport, Ill., is enlarging its plant. Will install electrical-power equipment.

The American Steel and Wire Company will immediately erect a $1,250,000 blast furnace at Cleveland, Ohio.

The plant of the Fletcher Enameling Company, Anderson, Ind., was destroyed by fire. Loss, about $50,000.

The Northland Lumber Company, Green Bay, Wis., is to install new woodworking tools and other machinery.

The Dayton (Ohio) Stucco Company, a new concern, has taken out a permit for the construction of a plant.

Beall Bros., Alton, Ill., whose shovel plant was recently burned, have started to rebuild same on a larger scale.

The Sybenga Manufacturing Company, of Pella, Ia., making paper bags and novelties, will move to Des Moines.

The Delaware & Hudson Railroad Company is purchasing ground in Watervliet, N. Y., for machine shops.

Fire destroyed the mill room and lumber shed at the Jewett Car Works, Newark, Ohio, causing a loss of $200,000.

The River Falls (N. C.) Cotton Mills Company has increased its capital and plans to build a $10,000 spindle mill.

Fire practically destroyed the plant of the Ideal Plating Company, Marlboro, Mass., causing a loss of about $30,000.

The Tioga Traction Company, Wellsboro, Penn., is planning to build a new turbine power plant and repair shops.

The Sylvan Cotton Mill Company, Shelbyville, Tenn., will install new water wheels and make other improvements.

The Hancock Manufacturing Company, Charlotte, Mich., will add a new brass and manganese foundry to its plant.

The Crescent Tool Works, Jamestown, N. Y., has completed the erection of a forge shop. Equipment not all ordered.

The Acme Steel and Malleable Iron Works, Buffalo, N. Y., has purchased ground on which a new tool shop will be erected.

The George E. Seidel Company, Richmond, Ind., has secured a building for its automobile factory. Equipment will be needed.

The Chicago, Burlington & Quincy Railroad will purchase new tools for the West Burlington, Iowa, shops about February 1.

The Reliance Boiler Works, Milwaukee, Wis., has secured a permit for the construction of a factory building to cost $15,000.

The Chandler & Price Company, Cleveland, Ohio, manufacturing printing machinery, will build a $100,000 addition to its plant.

The Haensel and Everett Company, Torreon, Coah., Mex., boiler makers, is in the market for drill press, lathe, rolls, shears, etc.

J. F. Boyd, Shelbyville, Tenn., operating electric-light plant and flour mill, will install new water wheels and make other improvements.

The Hobbs Manufacturing Company, Worcester, Mass., building paper box and woodworking machinery, will build a four-story addition.

The Sheldon Axle Company, Wilkes-Barre, Penn., intends installing equipment for the manufacture of springs and axles for automobiles.

The Mount Vernon (Ill.) Car Manufacturing Company has awarded contract for the construction of a new plant. This is to cost $1,000,000.

The King Sewing Machine Company, 254 Court street, Buffalo, N. Y., has leased ground on which a plant to cost about $150,000 will be erected.

The Foster Switch Company, Fillmore, Ind., will erect a plant for the manufacture of equipment for steam roads and electric traction lines.

The Union Packing and Refrigerating Company, 99 State street, Boston, Mass., has completed plans and specifications for a plant at Montvale, Mass.

The Stierlin Piano Company, St. Louis, Mo., has taken out a permit for the erection of a plant, which will be the first piano factory west of the Mississippi.

H. A. Robinson, of Akron, Ohio, is organizing a company for the purpose of erecting a plant for making sewer pipe and other clay products in Cleveland, Ohio.

The Liquid Carbonic Company, Chicago, Ill., has commenced the erection of a new soda-water fountain plant, which, it is said, will be the largest in the world.

The plant of the Crown Manufacturing Company, Phelps, N. Y., destroyed by fire several months ago, is to be rebuilt. The company manufactures grain drills.

The Dean Manufacturing and Foundry Company, Seymour, Wis., is to be equipped to manufacture automobiles. The company has been formed by local business men for the purpose.

John W. Hubbard & Co., of Pittsburg, Penn., has purchased the Davidson foundry at East Chicago, Ind., and will remodel same at a cost of about $300,000. Output will be steel and iron castings.

The Wilcox Engineering Company, Saginaw, Mich., is erecting a new plant and will double the present output. The company manufactures automobile parts, salt works machinery, copper and metal products.

George A. Koppel, founder of the Koppel Company, Koppel, Penn., manufacturing industrial cars, etc., has formed a new company which will be known as the Orenstein-Koppel Company and about $3,000,000 will be spent in improvements.

The Toledo (Ohio) Machine and Tool Company, which, a short time ago, added 65,000 feet additional floor space, has bought more ground and plans are being prepared for more buildings with a floor space of about 200,000 square feet.

The American Sanitary Manufacturing Company, of Detroit, Mich., will move to

Abingdon, Ill., where a new plant will be erected. The company manufactures brass fittings for bath rooms, and also operates a general brass foundry.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: January 18—Engine lathes, turret lathe, die-sinking machine, drilling machine, milling machine, slotting machine, automatic bevel gear planer (schedule 2093), vertical high-power miller (schedule 2111); January 25—Duplex chain blocks, air compressors (schedule 2110); February 1—21-horsepower engine (schedule 2114).

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: January 11—Boring bars (schedule 2097), steam jacketed kettles (schedule 2098), sheet brass, copper (schedule 2102), galvanized and corrugated iron, structural steel (schedule 2097), bar steel (schedule 2099), hacksaw blades, bolts, nuts, steel washers (schedule 2100), steel tubes (schedule 2096), brass tubes (schedule 2102), gasolene engines (schedule 2089), pneumatic chipping and calking hammer, pneumatic scaling hammers, pneumatic drilling machines (schedule 2088).

New Incorporations

Aëromobile Company of America, 26 Warren street, New York. Manufacture aëroplanes. Capital, $1,000,000.

Portsmouth Manufacturing Company, Kittery, Me. Manufacture machinery and tools. Capital, $50,000. J. K. Bates, president.

Winchester Pump Company, Winchester, Ind. Manufacture pumps and engines. Capital, $10,000. Incorporators, W. E. Miller, H. F. Hobbick, etc.

Markt & Co., Hoboken, N. J. Manufacture machinery, hardware, tools. Capital, $25,000. Incorporators, Francis E. Neagle, Frank H. Vedder, Edw. J. Ryan.

Royal Equipment Company, Bridgeport, Conn. Manufacture articles of iron, etc. Capital, $50,000. Incorporators, E. B. Knowles, Arthur M. Marsh, S. Stoddard.

Markimsee Meter Company, New York. Manufacture meters and motors. Capital, $100,000. Incorporators, F. R. Kimbley, B. L. Seebye, A. J. Marshall.

Brown Wrench Company, Ronceverte, W. Va. Manufacture patent wrench. Capital, $50,000. Incorporators, C. P. Brown, J. F. Brown, F. B. Albert, etc.

Northern Indiana Brass Company, Elkhart, Ind. Manufacture brass fittings. Capital, $10,000. Incorporators, C. G. Schweitzer, S. Schweitzer, V. E. Schlotterback.

Columbus Rubber Company, Columbus, Ohio. Manufacture rubber goods. Capital, $25,000. Incorporators, G. Vonden Syinen, G. W. Cottrell, J. W. Tyler, etc.

Birmingham Manufacturing Company, Birmingham, Ala. Manufacture machinery. Capital, $35,000. Incorporators, J. L. Travis, Jas. Gibbons, Silas Bigelow, etc.

Eagle Manufacturing Company, Carlstadt, N. J. Manufacture brass goods. Capital, $15,000. Incorporators, Edward Heran, Edward Wagner, Wm. F. Wagner.

Union Saw Company, Camden, N. J. Manufacture circular, band and hack saws. Capital, $250,000. Incorporators, F. R. Hansell, G. H. B. Martin, J. A. MacPeak.

Northern Indiana Brass Foundry Company, Elkhart, Ind. Manufacture brass fittings. Capital, $10,000. Incorporators, C. G. Schweitzer, S. Schweitzer, V. E. Schlotterback.

Joliet Concrete Machinery Company, Joliet, Ill. Manufacture concrete machinery and products. Capital, $25,000. Incorporators, James Straka, E. Meers, M. F. Lennon.

Pittsburg Nail and Supply Company, Jersey City, N. J. Manufacture nails, etc. Capital, $50,000. Incorporators, H. C. Alberts, J. R. Turner, S. A. Anderson, Jersey City.

Hammacher, Delino & Co., Hoboken, N. J. Manufacture machinery, hardware, tools. Capital, $25,000. Incorporators, Francis E. Neagle, Frank H. Vedder, John P. Walsh.

C. P. Weeden Motor Company, Trenton, N. J. Manufacture automobiles, motor cycles, etc. Capital, $100,000. Incorporators, C. P. Weeden, J. B. Weeden, J. S. Valentine, etc.

Armon Manufacturing Company, Jersey City, N. J. Manufacture cotton, cotton yarns, cloth goods, etc. Capital, $150,000. Incorporators, E. C. Parker, L. J. Relyea, F. E. Griswold.

Metallic Art Company, Newark, N. J. Manufacture metal, wood, lead, brass, copper, paper and leather novelties. Capital, $100,000. Incorporators, C. H. Bruce, F. A. Nott, Jr., M. S. Drake, Jr.

Mumford Molding Machine Company, West Orange, N. J. Manufacture machines, engines, motors. Capital, $125,000. Incorporators, W. D. Sargent, West Orange; G. M. Judd, E. H. Fallows, New York.

Demotocar Car Company, Trenton, N. J. Manufacture automobiles, trucks, carriages, etc. Capital, $1,000,000. Incorporators, Frank T. Lodge, Stanton Clarke, John C. Krieg, Detroit; John A. Hartpence, Trenton.

Business Items

The Sebastian Lathe Company, Cincinnati, Ohio, has increased its capital stock to $100,000.

The Hess-Bright Manufacturing Company, Philadelphia, Penn., will open a Chicago branch at 1800 Michigan avenue, about January 20, 1910.

The Colton Combination Tool Company has moved its plant from East Hampton, Mass., to Chester, Vt. At a recent meeting of the directors the following officers were elected: Gorham C. Parker, president; William A. Felt, vice-president; Percy E. Heald, treasurer, and Rosto E. Colton, superintendent.

The business of the Kelly Tool Company has been taken over by the Kelly Reamer Company, who will manufacture the Kelly adjustable reamer and other tools and devices. The concern is an Ohio corporation with $25,000 capital stock, with the following organization: William E. Kelly, president and general manager; Albert H. Weed, vice-president; John M. Marty, secretary and treasurer. An office and factory have been opened at 522 Prospect avenue, N. W., Cleveland, Ohio.

Trade Catalogs

Niles-Bement-Pond Company, 111 Broadway, New York. Catalog describing Pond rigid turret lathe. Illustrated, 44 pages, 9x12 inches.

Rockwell Furnace Company, 26 Cortlandt street, New York. Bulletin G. Annealing, hardening, tempering furnaces. Illustrated, 8 pages, 9x12 inches.

The American Oxhydric Company, Milwaukee, Wis. Catalog of apparatus for the cutting and welding of metals by means of oxygen and hydrogen. Illustrated, 24 pages, 6x9 inches, paper.

The Emerson Electric Manufacturing Company, St. Louis, Mo. Bulletin No. 3137 on 1/15- to ½-horsepower single-phase induction motors. Illustrated, 4 pages, 7x10 inches. Bulletin No. 3309, describing electric forge blowers. Illustrated, 8 pages, 7x10 inches.

Forthcoming Meetings

Society of Automobile Engineers, professional meeting, January 13, Engineering Societies building, New York City. Alex. Churchward, secretary, 2 Rector street, New York City.

American Foundrymen's Association and American Brass Founders Association; joint convention, June 7-8-9, Detroit, Mich.; headquarters, Hotel Pontchartrain. Richard Moldenke, secretary, Watchung, N. J.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Man with good experience wants position to take charge of tool room or manufacturing department on small or medium size work; have handled both. Box 26, AMER. MACH.

An American, 40 years old, with 25 years' experience as a toolmaker, machinist and foreman in the machine tool line; now employed, but wish to change; a good organizer; have first-class references. Box 48, AM. MA.

MASSACHUSETTS

Responsible position by practical mechanic with theoretical knowledge; wide office and factory experience; designer of special machinery and tools; factory superintendent, etc. Box 49, AMERICAN MACHINIST.

MICHIGAN

Shop superintendent or foreman; practical mechanic and executive in machine building, cost reducing and up-to-date methods of manufacturing interchangeable parts; 20 years' experience; best of references. Box 17, AM. M.

NEW JERSEY

Office executive and systematizer, 33, thoroughly trained, seeks responsible position; 15 years' machine manufacturing experience; master of all office details, excellent correspondent, experienced advertiser, good executive ability and an organizer with capacity to do things; references the best. Box 6, AMERICAN MACHINIST.

NEW YORK

Superintendent, experienced on automatic machinery, screw machines and sheet metal drawing, also general machine work, wishes position as superintendent or general foreman; straight salary or percentage basis. Box 39, AMERICAN MACHINIST.

OHIO

Are you looking for a first-class designer with engineering education and experience. If so, address Box 34, AMERICAN MACHINIST.

Superintendent, now employed, desires a change; gasolene engines, steam pumps, special machinery, tool building; a hustler with an earning power; go anywhere. Box 47, AMERICAN MACHINIST.

OREGON

Master mechanic; responsible, live man experienced in construction and manufacturing in the States, Canada and South America; age 39. B. Nilius, St. Johns, Oregon.

6000 HORSEPOWER ABSORPTION DYNAMOMETER

Design Solved New Problem in Water Brake

SPECIAL CORRESPONDENCE

For measuring the power output of prime movers, such as steam engines and electric motors, the prony brake has for a long time been considered a satisfactory piece of experimental apparatus when handling moderate powers. This device, as is fairly well known, usually consists of bands of rope put around the rim of the flywheel, these bands being attached to a frame resting upon a balance scale, the wheel revolving inside the bands, which remain stationary. Suitable means are provided for applying tension to the ropes to make more friction on the flywheel rim and thus increase the resistance to the rotation of the flywheel and consequently the pressure upon the scale.

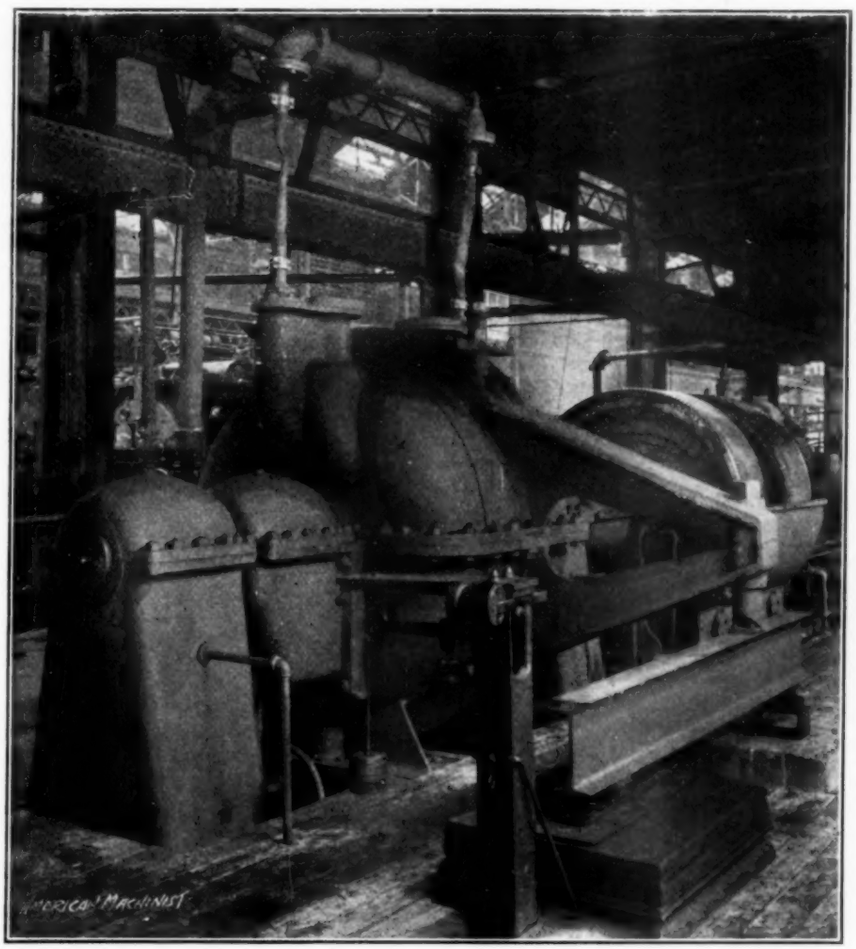


FIG. 1. DYNAMOMETER ASSEMBLED FOR THE TEST. MELVILLE-MACALPINE GEARS IN THE BACKGROUND

In this way it is clearly seen that the power of the machine to be tested is transformed into heat due to the friction of the bands and this heat is carried off by a stream of water which flows into the inside of the rim, is carried around by the centrifugal force and finally scooped out at some other point by a suitable overflow pipe. Another evidence of the friction produced is the tendency to rotate the band, and this is measured by the downward pressure upon the scale which resists this rotating tendency.

To calculate the horsepower delivered it is assumed that the force measured by the scale is acting at a lever arm equal to the distance from the center of the wheel to the point of support at the scale, and that if the band were allowed to rotate, it would make as many revolutions per minute as the wheel does. The two elements of work, that is, force (the pressure upon the scale) and the distance traveled in a given time (the circumference corresponding to the lever-arm radius, multiplied by the revolutions per minute) are then both known, and their multiplication will give the power being absorbed by the prony brake.

WATER BRAKES

Such a device as this is suitable for moderate power, but when more than about 200 horsepower is required to be measured, the heat generated becomes excessive and the difficulties of constructing the brake with sufficient area to carry off this heat make it a practical impossibility. For the purpose of testing steam turbines, manufacturers have for some time been using what is known as a water brake. This device uses practically the same principle as the prony brake, with the exception that the energy developed by the turbine is absorbed in churning up a quantity of water so that its temperature is raised, and in fact some of the water is boiled away. This device is suitable for much larger powers than the prony brake.

In a water brake the essential features are a rotor mounted upon the shaft which is delivering the power, a stator which surrounds the rotor, and a quantity of water between the two. The stator is provided with a lever arm which protrudes from one side, so that it may rest upon a scale, the weight of the stator body being supported by bearings on the revolving shafts. In the periphery of the rotor, which is of cast iron, there are blades, somewhat like those of a paddle wheel, with the exception that they are inclined forward, and furthermore, are in two diagonal sections, something like the teeth of a herringbone gear. Surrounding the rotor there is the cast-iron shell of the stator and on the inside of this there are other blades arranged somewhat like the teeth of an internal ratchet. These teeth are not very deep, but are faced in such a direction that the water which is admitted between the revolving and stationary elements, is thrown with great violence by the rotating blades against the faces of the ratchet teeth on the inside of the stator. This violent throwing of the water not only heats it up and causes some of it to boil away, but the impact of the water against the blades of the stator causes the same tendency to rotate that there is in the ordinary prony brake. This tendency shows itself in a force at the end of the lever arm bearing down upon the scale. Again, in this de-

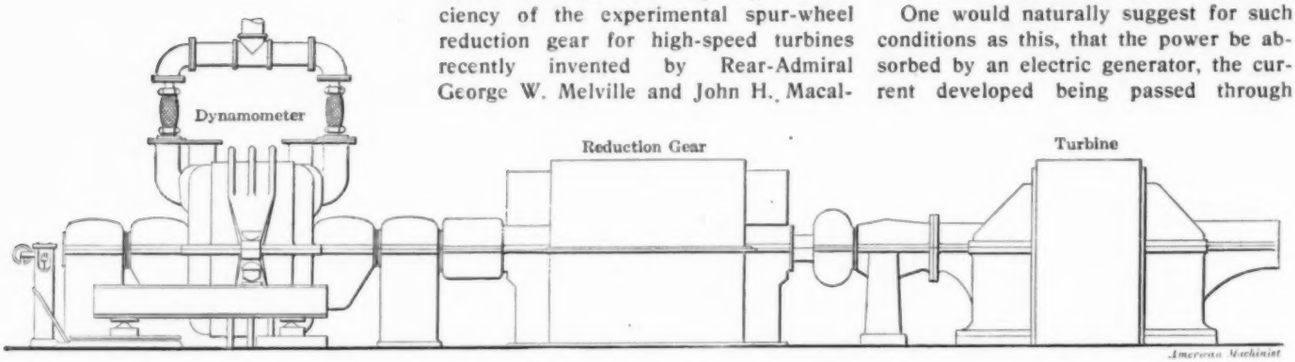


FIG. 2. GENERAL ARRANGEMENT OF APPARATUS

vice, by noting the pressure on the scale and the speed of the shaft, the horsepower is easily calculated. The load upon the machine is adjusted by the amount of water admitted to the brake, and this is controlled by valves.

THE NEW PROBLEM

These water brakes are suitable for high speeds; that is, from 750 revolutions per minute to 4000 or more, the former figure being for large machines and the latter for small ones. Of late, however, there has been a call for a water brake involving a new problem in the fact that it would be necessary to absorb 6000 effective horsepower at the comparatively low speed of 300 revolutions per minute.

Necessity for this brake was due to the desire to measure the capacity and efficiency of the experimental spur-wheel reduction gear for high-speed turbines recently invented by Rear-Admiral George W. Melville and John H. Macalpine, and constructed by the Westinghouse Machine Company, to whom we are indebted for the accompanying illustrations. A brake for such conditions as this was entirely unprecedented. First, the development of 6000 horsepower, if transformed into heat, is practically equal to that which would be generated in a furnace burning coal continuously at the rate of 1200 pounds per hour. If such a brake could be constructed in the prony type the speed of 300 revolutions per minute would limit the diameter of the brake wheel to 6 or 7 feet, and in order to get sufficient surface to absorb the power, the face of this wheel would have to be at least 30 feet long. Such a brake, of course, could not be practically constructed.

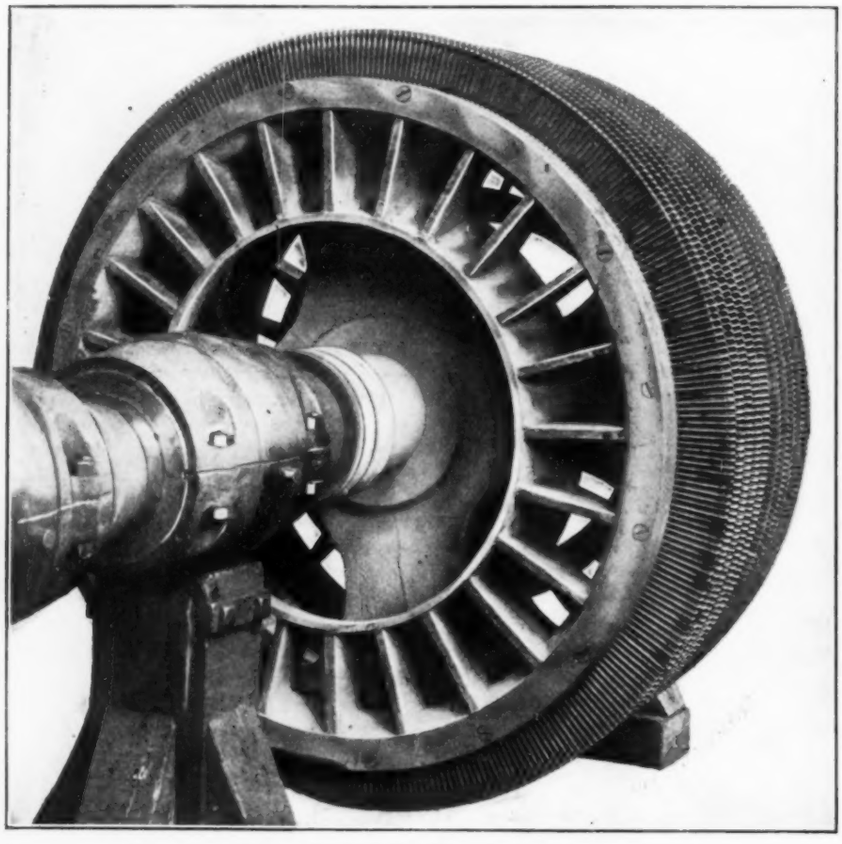


FIG. 3. SIDE VIEW OF ROTOR SHOWING WATER PASSAGES

ELECTRIC GENERATOR NOT SUITABLE

One would naturally suggest for such conditions as this, that the power be absorbed by an electric generator, the current developed being passed through water resistance, in order to vary the load as desired. The trouble with this is that the generator would be cumbersome and expensive, and many of the losses such as windage, eddy currents, etc., in the generator itself make the measurement of the power subject to certain assumptions which to a considerable extent invalidate the object of the tests, namely, to accurately measure the output and also the efficiency of the gearing.

SOLUTION: THE TURBINE BRAKE

Such an electric generator not being suitable, the idea of using the old-style water brake would, of course, suggest itself, but it was recognized that the excessive power at the extremely low speed would necessitate some change in design. This is exactly what was settled upon, and the hydraulic brake, herewith illustrated, was developed by Raymond N. Ehrhart, of the Westinghouse engineering staff, for this purpose. The principle involved is practically the same as that of the ordinary water brake, with the exception that the principle of the steam turbine, reversed, was incorporated; the object being to get the violent churning effect at the lower speed and to obtain it in a machine of practical size.

Fig. 1 shows the general outside view of the apparatus assembled for experiment, the part in the foreground, looking not unlike a large centrifugal pump, is the stator casing of the dynamometer. At the right will be seen the lever arm extending from the shell and resting with a knife edge upon an I-beam, which in turn rests upon a fulcrum in the distance and the scale in the foreground. By this double-lever system the pressure of the rotating tendency is reduced in the ratio of 1 to 4, and so is easily and accurately measured upon standard scales. In Fig. 1, in the distance, also will be seen the two large spur gears of the Melville-Macalpine device. These gears are mounted directly on the shaft upon which is also mounted the rotor of the dynamometer.

At the top of the stator will be seen the two rubber-hose pipes through which water is admitted to the dynamometer casing. That portion of the water which

is transformed into steam by the violent churning action comes out through the top of the shell where two bank flanges are seen in the halftone. The water which does not boil away passes out through two pipes at the bottom of the casing, the openings being regulated by valves on the ends of these pipes. There are two objections to allowing the energy to be used in boiling all the water in the casing. In the first place, if it should all boil away suddenly the load would be at once removed from the dynamometer, and secondly, the violent boiling action makes it difficult to regulate the quantity of water in the casing and makes the pressure upon the scale very irregular, so that uniform results are difficult to obtain. When in operation, an attendant carefully adjusts the amount of water flowing so that the pressure upon the scale beam is just balanced at a constant point, thus showing that the load transmitted by the gears tested is also constant.

As with the ordinary water brake, the load may be varied by adjusting the water supply. Fig. 2 shows the general arrangement of the apparatus, the steam turbine being on the right and the reduction gear in the middle with the dynamometer at the left. Fig. 3 shows a side view of the rotor, the large grid openings in the side being those shown at *F* in Fig. 5. In Fig. 3 also, are clearly seen the turbine blades in the periphery of the rotor. These blades, as in turbine design, are dovetailed into the rotor frame and laced together near the outer ends by the wire shown in the halftone. This wire is of peculiar shape, being not unlike a comma in section. The holes punched through the blades are also of the same section, and after the wire is passed through all the holes, and the blades have been carefully spaced, the tail of the comma between the blades is forcibly bent out by suitable pliers so as to act as spacing pieces. The blades on the two ends of the rotor are turned in opposite directions, as is clearly seen in Fig. 6, which also shows the water passages through the center of the rotor. Fig. 4 shows the inside view of the stator, the blades of which are flat.

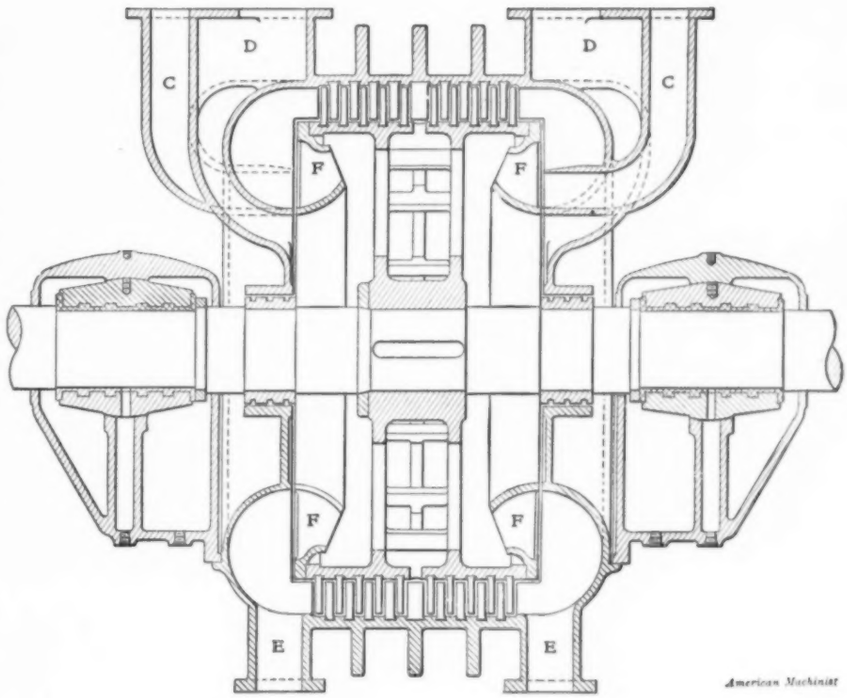


FIG. 5. CROSS-SECTION THROUGH ASSEMBLED DYNAMOMETER

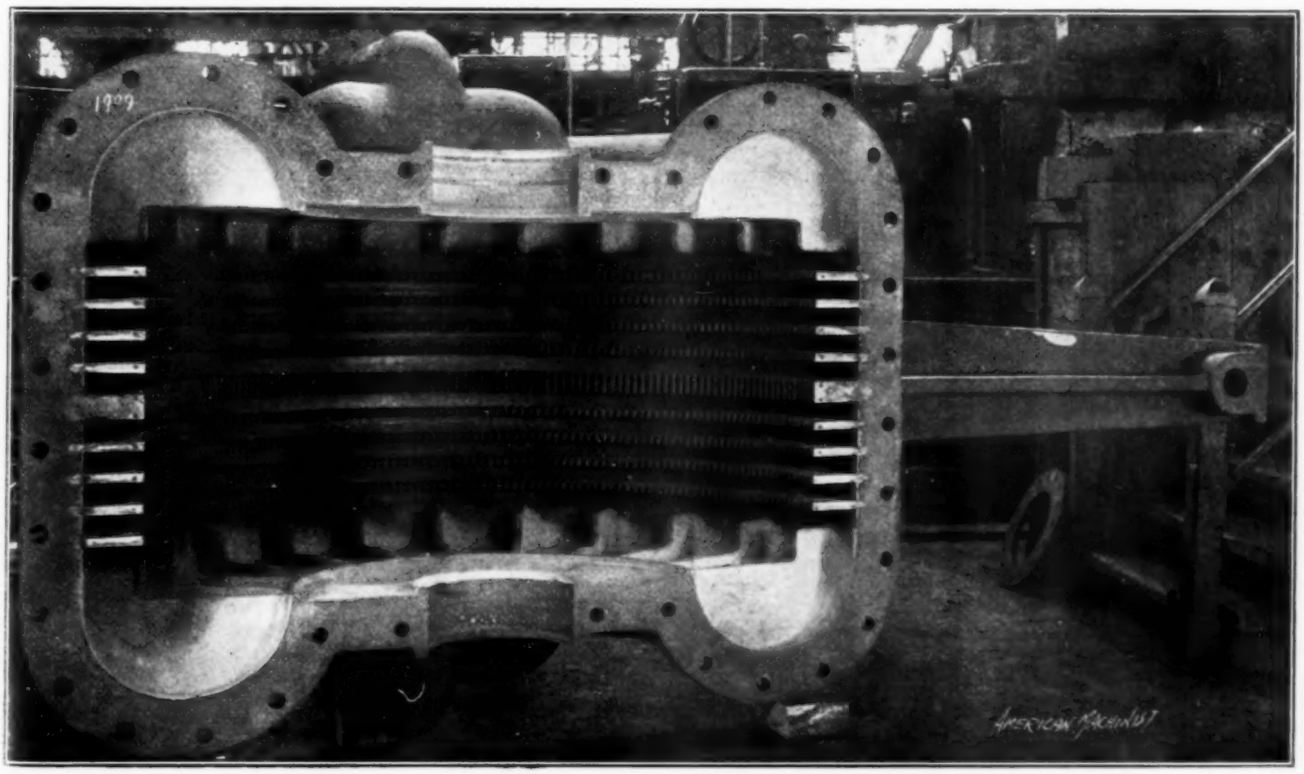


FIG. 4. INSIDE VIEW OF STATOR SHOWING FLAT STATIONARY BLADES INSIDE AND LEVER ARM AT RIGHT

The Action

With this description of the parts, the action of the device will be easily understood. Referring to Fig. 5, the water enters the casing through the passages marked *C*. The passages marked *D* are for the escape of steam generated by the transformation of the power into heat. As said, it is not practical to carry off all the heat by evaporation alone. If this were done, it would mean the generation of 15,000 pounds of steam per hour, giving rise to the difficulties already mentioned. Water entering through the passages *C* flows into the center of the rotor, is thrown out through the central ports, which in Fig. 7 are marked *A*, and from there to each side, being caught by the rapidly revolving turbine blades of the rotor. These blades are shown in solid black in Fig. 7, while the cross-hatched areas represent the flat blades of the stator.

After being violently whirled through the first set of movable blades, the water passes through a set of stationary blades, from there to the next set of movable blades and so on, being alternately whirled around and retarded by the moving and stationary blades, until what has not already been evaporated, is discharged at each side into the semi-circular passages, from which it again flows into the center of the rotor. Here it mixes with the fresh water coming in through the inlet passages and again goes through the central ports of the rotor, out into the blades and around and around as the action continues. The surplus water flows out through the bottom, as shown by the passages *E E* in Fig. 5, and by the time it comes out of these passages it is practically at boiling temperature. The semi-circular passages are also cast with baffles, as shown in Fig. 4, to assist in retarding the rotation of the water.

In the calculation of the horsepower developed, it is, of course, first necessary to determine the zero reading, or the dead weight of the overhanging lever arm.

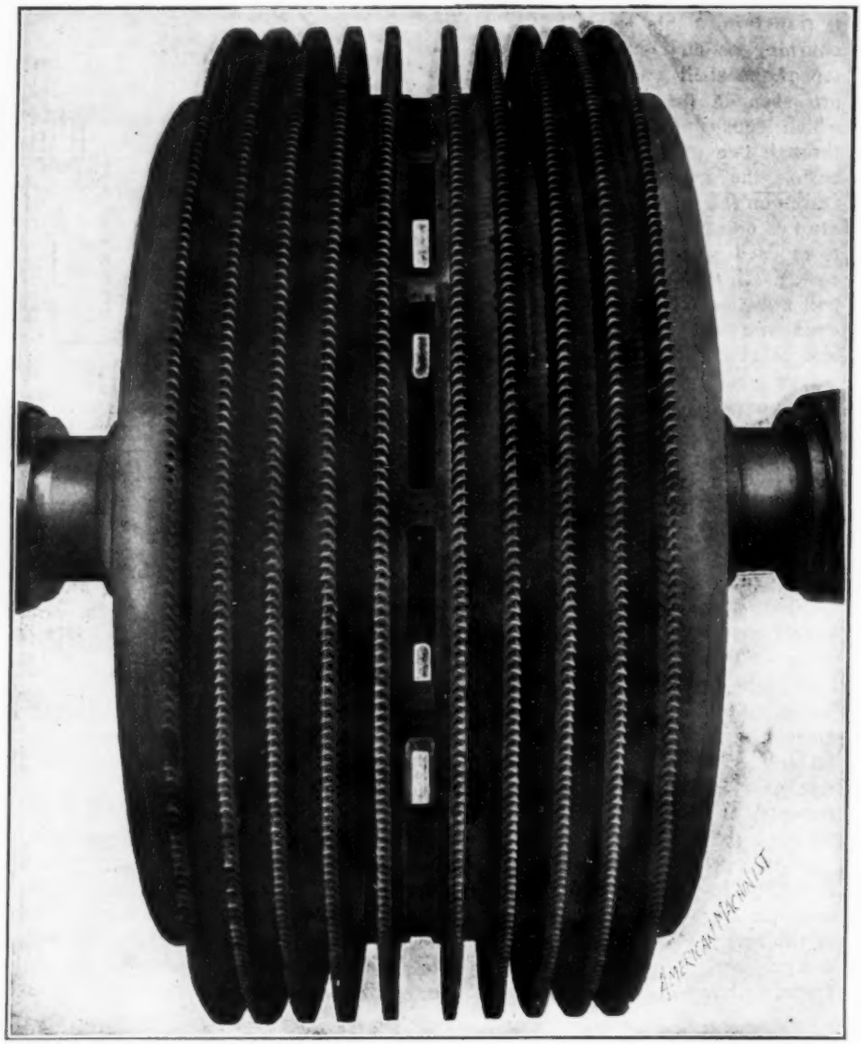


Fig. 6. View of Rotor Showing Turbine Blades and Center Water Passages

Moreover, as the journal friction affects this very materially when standing still, a screw jack was interposed between the lever arm and the scale, and weight readings were taken when screwing the jack both up and down. The mean between these two was taken as the correct zero reading.

The Input

So far we have considered only the measurement of the output of power. It has already been said that the object of

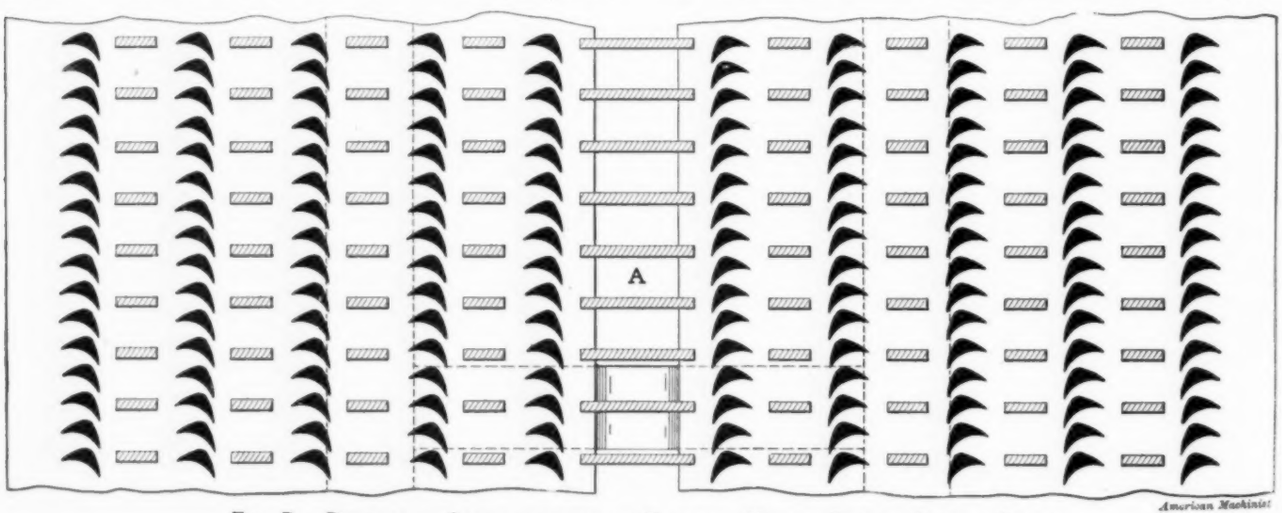


Fig. 7. Developed Section through Blades. Moving Blades Shown Solid; Stationary Blades Shown Cross-hatched

the test was to determine the efficiency of the gearing. In order to do this, it is just as essential to know the input as to know the output. In order to determine the input for this particular set of experiments, a steam turbine, of suitable size and speed, was carried through a long series of brake tests from which it was found that for each speed and load, with a constant vacuum, and with steam of uniform quality, there is a corresponding inlet steam pressure. By varying the conditions and measuring the output of the turbine, the turbine itself was practically calibrated so that for any given set of conditions, the actual output could be accurately predicted. In this way, then, knowing the output of the turbine for a given set of conditions, and measuring the power absorbed by the dynamometer, the efficiency of the gearing was easily determined. It is said that this dynamometer has been an entire success in spite of the fact that it was radically new.

Punch and Die with Close Fitting Stripper

By F. Greiner

It is a fact well known to die makers that blanking dies are not worn out so much during the actual process of separating blanks from a strip of metal, as they are by reason of the so-called shearing action which takes place between the punch and the die. This shearing may be caused through a number of defects, such as a worn out condition of the press itself, or short bends and curves in the stock to be operated upon. It also happens frequently that the operator slips with his hand when pressing down the treadle, thus throwing the weight of his body upon the foot and losing the necessary firm grip on the stock operated upon. The invariable result of this is, that the stock finds its way to the top of the stop pin, causing a considerable side pressure to be exerted upon the punches, and shearing is sure to follow.

Another reason why shearing takes place is that dies are not always set with the proper care. To set a die properly carrying a number of punches requires considerable skill, and this operation is frequently left to the tender mercies of an unskilled or careless press hand. In the subpress most of these unfavorable conditions are avoided because its respective punches and dies are not subjected to any outside disturbances.

Tools for Special Forms of Blanks

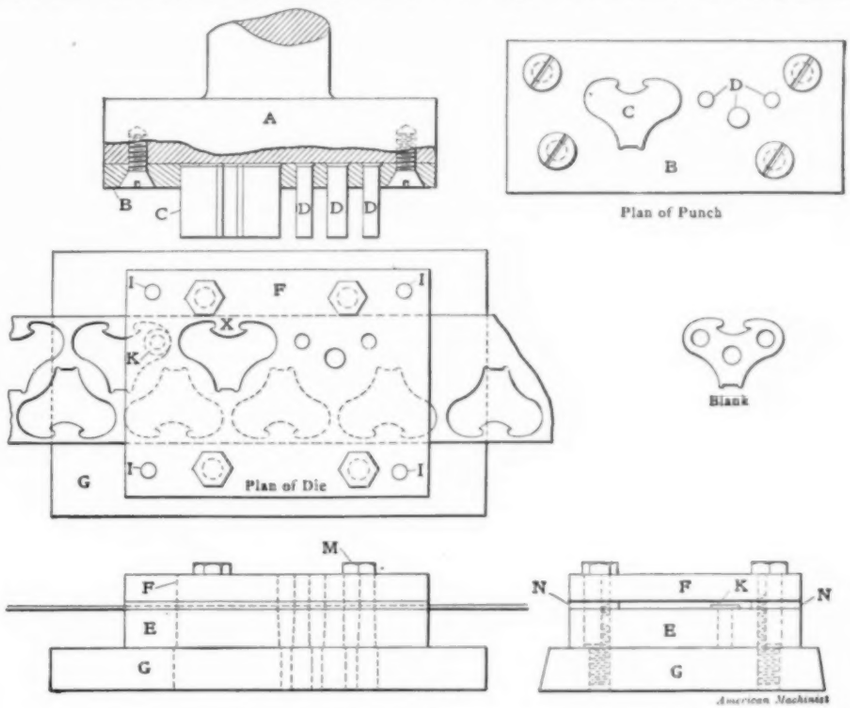
The accompanying sketch shows a punch and die, the construction of which is not met with in ordinary shop practice as often as it should be, considering its advantages over the common loose-fitting stripper die. This type of die is particularly adapted to contours which necessitate weak parts in punch or die, or to blanks which are small in proportion to the thickness of stock from which they are punched.

As will be seen, the die differs from any other of its kind in so far that it has a comparatively heavy stripper, fitting very closely to the punches, so that no amount of side pressure can cause these to deviate from their proper path. It produces neat, flat blanks, absolutely without bur; and after tumbling them with sawdust they are nickel-plated and colored, doing away with the polishing process entirely. The stock used in this case is 1/16x2-inch hard, bright, cold-rolled steel.

Close Stripper Advantages

The "layout" in this particular instance might have been more economical; that is, somewhat narrower stock might have been used; however, this width happened to be on hand, and, as a rule, only several thousand are made at a time. Also it would mean that an odd width of stock would have to be sheared, thus adding to the expense, or it would have to be ordered specially, causing unavoidable delay.

It may be readily seen that the die, if made of the loose-fitting stripper type, would suffer if a careless operator should place the stock on top of the stop pin *K*, as the slender part *X* would hardly withstand the side pressure exerted upon it and would either chip or break. With the close-fitting construction, however, no harm results, as the stripper does not allow the punches to deviate from their proper path and a short bend in the stock operated upon is the only consequence. Again, in setting the die it is merely necessary to insert the punch loosely into the stripper plate *F*, make all the adjustments excepting that of the stroke, tighten up all around in proper relation, then adjust the stroke, and the punches never come into contact with the die until the alinement is perfect.



Punch and Die with Close-fitting Stripper

Making the Die

To build up a die of this kind we proceed as follows: The die *E* is machined, laid out and finished complete including hardening and grinding. The punches *C* and *D* are made next. Punch *C* has the shape of the blank throughout its entire length, a practice which allows of its use in lining up later on with a minimum chance for errors. Punches *D D D* are simply pieces of drill rod, hardened all over with the rivet head drawn blue. This is important, as the heads will chip off if left too hard.

The straight part imbedded in *B* must be hard, however, or the punches will

upset and buckle, unless the stock to be operated upon be very thin. Punch *C* is only hardened about half way, as its bulk protects it from upsetting.

Operations on the Stripper to Produce Proper Fit

We now proceed to the stripper *F*. Cold-rolled flats are made with such accuracy both in size as well as in shape, that it is not necessary to do any machining. We clamp the stripper to the die and scribe off the shape of the wing through the back of the die, using an ordinary sewing needle. Next we drill out the surplus stock the same way as in making the die proper and finish by filing, using the punch *C* in the same manner as a broach.

It is good practice to file as close to the line as possible so that the punch may be just about started, then to squeeze the latter into the stripper a trifle, using the vise for this purpose, always oiling the punch after each successive squeeze, until the punch has been worked through the entire thickness of the stripper. When done, the fit between the punch and stripper should be so, that a gentle pressure is required to push the one through the other.

The Bottom Plate for the Die to Support Weak Parts

Now, the die is placed on top of the plate *G*, also of cold-rolled steel and the four dowel-pin holes *I*, as well as the four holes for the screws *M* are transferred through the die. In most dies this bottom plate may be dispensed with, but here it is used to give proper support to the weak parts *X*.

The holes for *M* are tapped and the die is fastened to *G* by means of two of the screws *M*, the shape of the blank is scribed off, and the surplus stock is drilled out, no accuracy being required as it is merely desired to increase the strength of *X*.

Locating Screw Holes and Guide Strips

We now insert the punch *C* through the stripper plate and enter it slightly into the die, clamping both stripper and die together as near to the holes for *M* in the die as possible, and the four holes for *M* are drilled into the stripper plate. They should not, of course, be binding on the screws, as these, as commercially sold, are seldom true enough to be depended upon; and as the alinement between stripper and die is not fixed by them, but by the dowel pins *I*.

The guide strips *N N* are now drilled. When laying out a die, it is always well to draw two lines representing the width of the stock from which the blanks are to be punched, so that the first grinding will not eliminate them. To obtain the proper location the guide strips *N* are clamped to the die, using these lines as guides.

Securing Stripper to Die

To proceed further, punch *C* is again pushed through the stripper plate and left protruding far enough to find its place inside of the die. The four screws *M* are then screwed home, clamping *F*, *E* and *G* together and the holes for *D D D* are spotted, drilled and reamed from the back into the stripper *F*. Before starting on these holes for punches *D*, it is well to tap out the punch *C*, to make sure that the alinement between *F* and *E* is perfect. This will appear at once if the punch is inserted again.

If the tightening of the screws *M* has forced the stripper out of line at all, it will be impossible to enter the punch into the die. Should this happen, the displacement must be corrected by tapping the stripper into line, which is made possible by the clearance holes in both stripper and die not binding upon the screws *M*.

Assembling the Complete Die

It is absolutely essential that the cycle of operations for building up the die be followed as described and that all these precautions be taken. I have made many dies of this type and found that any deviation invariably resulted disastrously to an absolute alinement; and unless these dies aline perfectly through the stripper, they are no better than the usual loose stripper variety with the added expense of the extra work naturally involved.

We now assemble the complete die including the guide strips *N N*. This time the three punches *D* are inserted into the die first and then the punch *C*, before the four screws *M* are screwed home and the holes for the four pins *I* are in turn spotted, drilled and reamed through the back with the four punches left in the die. The four pins *I*, previously cut off, may now be tapped into position, and it will be found that any of the four punches will slide through the stripper into the die without apparently touching it.

Finishing the Punch Plate

To lay out the shape of the punch *C* in the punch plate *B* we do not use the die, but the top of the stripper. The punch plate is clamped to the stripper in its natural position and the shape of *C* is scribed off. The surplus stock is removed and the punch is fitted, using it again as a broach. Between *C* and *B* the fit should be tight. When fitted, the stripper is slipped over the punch *C*, so that it is face to face with the punch plate *B*.

We now clamp both and spot, drill and ream the holes for the round punches *D* through the stripper into the punch successively, that is, spot one hole, drill and ream it; insert its punch through both *B* and *F*, repeat with the second hole, insert its punch and so with the last.

Dislodge the stripper by knocking out the punches and countersink the back of the four punch holes, so that when they are driven home their riveted tops will come flush with the back of *B*. To countersink for *C* use a three-cornered scaper.

Fitting the Round Punches

Very often it will happen that when it is attempted to enter the punches now secured in the punch plate into the stripper, they will not enter with perfect freedom. This is due to slight deflections caused in the hardening of the punches and may be easily overcome by tapping out two of the punches *D D* and trying, whether *C* and the remaining punch *D* will enter freely. If they do not, knock out the remaining punch *D* and try another in one of the other holes, until one of them in conjunction with *C* enters freely.

Now, insert another punch *D*, and if any binding takes place, correct the position of the last punch *D*, as this is bound to be the faulty one. To do this, we resort to staking with a small chisel. Then we go through the same operation with the remaining punch *D*, if any binding takes place when inserted.

Method of Securing Punches to Avoid Looseness

To make certain that none of the punches work loose under any circumstances the punch plate is placed on a thin piece of sheet iron over a bunsen burner, so that the heat strikes the back of the punches in the plate and they are sweated in, using strip solder. It is needless to say that the punches, as well as the holes, should be clean and free from grease. As soon as the solder runs, the heat is shut off and a straight piece of flat steel is placed across the top of the punches to prevent their getting too hot.

In tempering, the punches should be left a little harder than usual, as this sweating process naturally draws the temper a trifle. I have never known a punch to come loose which was treated in this manner.

In the case of small dies the screws *M* may have fillister heads, thus allowing shorter punches to be used.

Satisfactory Operation

It is surprising what little trouble a die of this type gives, if the alinement of the different parts is perfect. While it requires a little more time than the loose stripper kind, it calls for no repairs common to the latter and will produce blanks without burs even after a number of settings, without requiring grinding. In jewelry shops it will more than pay for itself, as it is well known that shearing causes a serious loss of gold, which cannot be recovered.

SOME TOOLS and TOOL ROOM METHODS

A Variety of Huge Micrometers and Rod Gages. Storage Arrangements

EDITORIAL CORRESPONDENCE

In the tool room of the Wm. Tod Engine Company, Youngstown, O., have been made some small tools which are interesting and are in practical use every day. Their method of filing blueprints that are being used in the machine shop, as well as the racks for tools in the tool room, are features that facilitate the work, as there is no time lost in looking through numerous piles of blueprints for the correct one or numerous racks for the proper tools.

Large Micrometers

Some of the largest micrometers that have been made for measuring round stuff are shown in Fig. 1, the largest of which will take 74 inches in diameter, and will give the accurate measurement of anything between 70 and 74 inches. The inch variations in measurement are obtained by moving the rod, shown to the right of the micrometers, in or out and clamping it where desired. On the opposite end, or to the left is shown the micrometer head for measurement to the thousandths of an inch.

Fig. 2. Racks for Machine-shop Blueprints

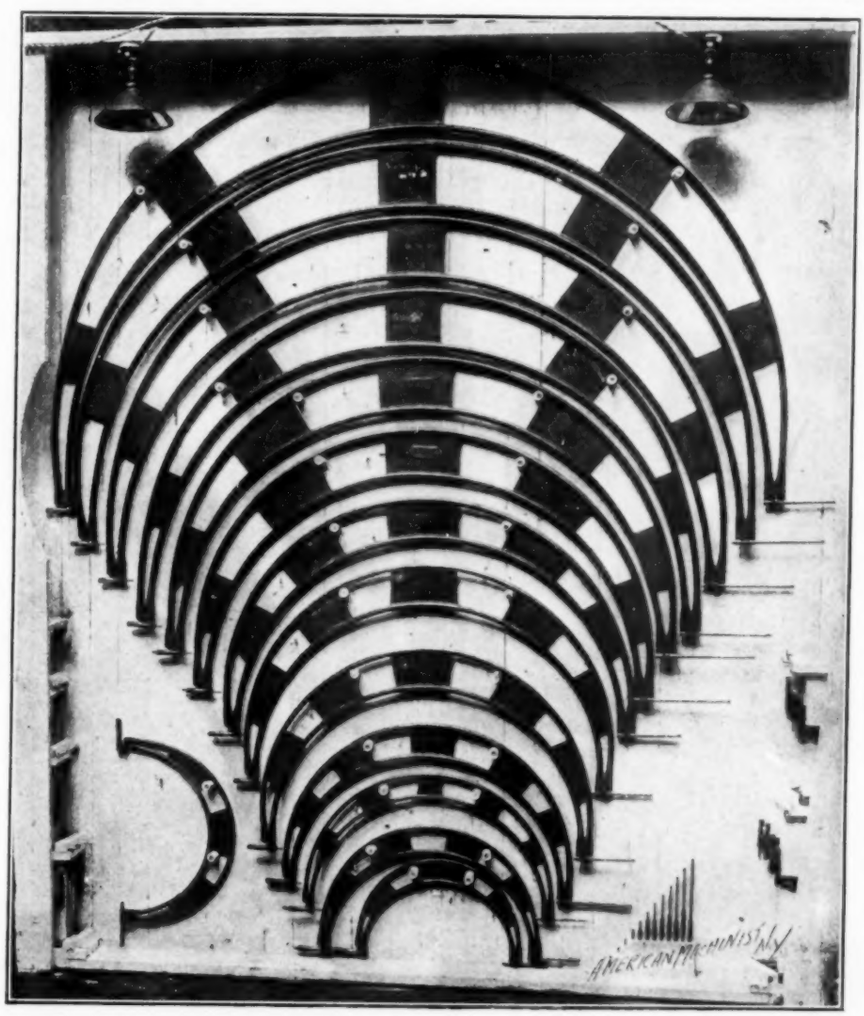


Fig. 1. Set of Micrometers with a Range of from 12 to 74 Inches

The next size below this one measures material from 66 to 70 inches, the next 62 to 66 inches, and so on down by steps of four inches until the smaller sizes are reached, and then they are reduced by steps of three inches. The smallest micrometer of this set will take in a piece 12 inches in diameter. The smaller sizes are shown in racks back of the casing board to the right, while the larger sizes are hung on pins on the board.

The making of the frame for these micrometers was quite a problem, but was finally solved by making the frame of two pieces of tubing and binding these together at five different places, other than the two ends, by strips of sheet metal. With the micrometers that can be bought this gives the company a range of measurement from nothing up to the largest size, which is 74 inches in diameter.

Filing Blueprints

The keeping of blueprints for the work done in the machine shops so they will not get soiled and can be found the second time they are needed has always been a problem with this company, as well as with others. The scheme they have adopted, however, seems to solve this problem in a very practical way, as it is not necessary to go to a draw and overhaul some 50 or more blueprints before the correct one can be found.

Their method of filing these is shown in Fig. 2 and consists of a large number of thin wooden slats that project out from a frame to which they are fastened in the back, and these are numbered consecutively so that when a blueprint of a certain number is required, it is only necessary to follow along the slats to the correct number, and then pick off the required blueprint, which in most cases is merely folded over the wooden strips.

This does away with the necessity of handling any of the prints except the one required, which makes them longer lived by not being soiled and torn, and the time consumed in finding the proper one is but a fraction of that used when they are kept in drawers.

In Fig. 3 is shown a set of rod gages that have effected a great saving by having the correct measurement instantly at hand. These are kept in a rack in the tool room in all sizes for each ⅛ of an inch from 1 up to 108 inches. The smaller sizes are kept in the rack shown, while the larger ones are in a rack suitable for them.

Above these rod gages are shown five micrometers of a different style, but the same as those shown in Fig. 1. These are used for measuring flat stock, and are kept in the tool room in various sizes.

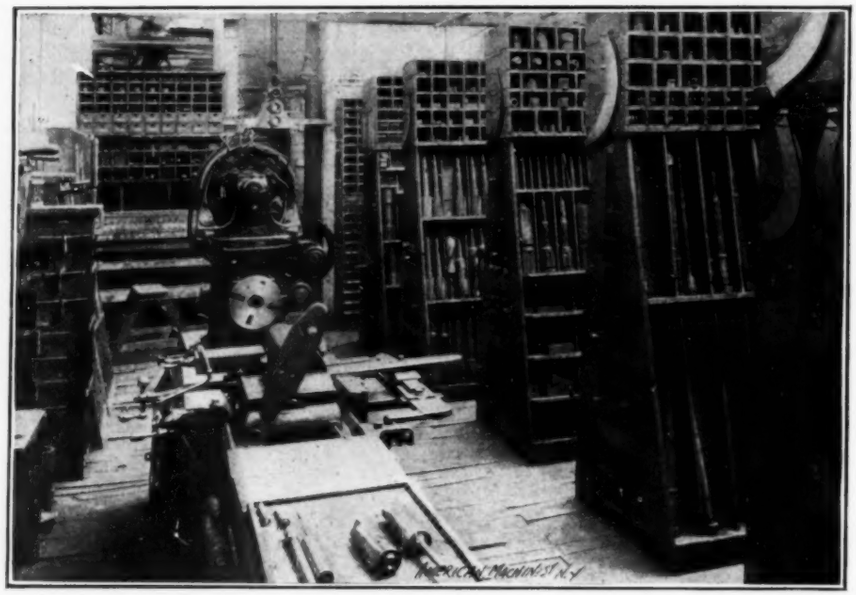


FIG. 4. TOOL-ROOM RACKS AND LATHE IN TOOL ROOM

TOOL RACKS

The method of racking the tools is shown by the corner of the tool room

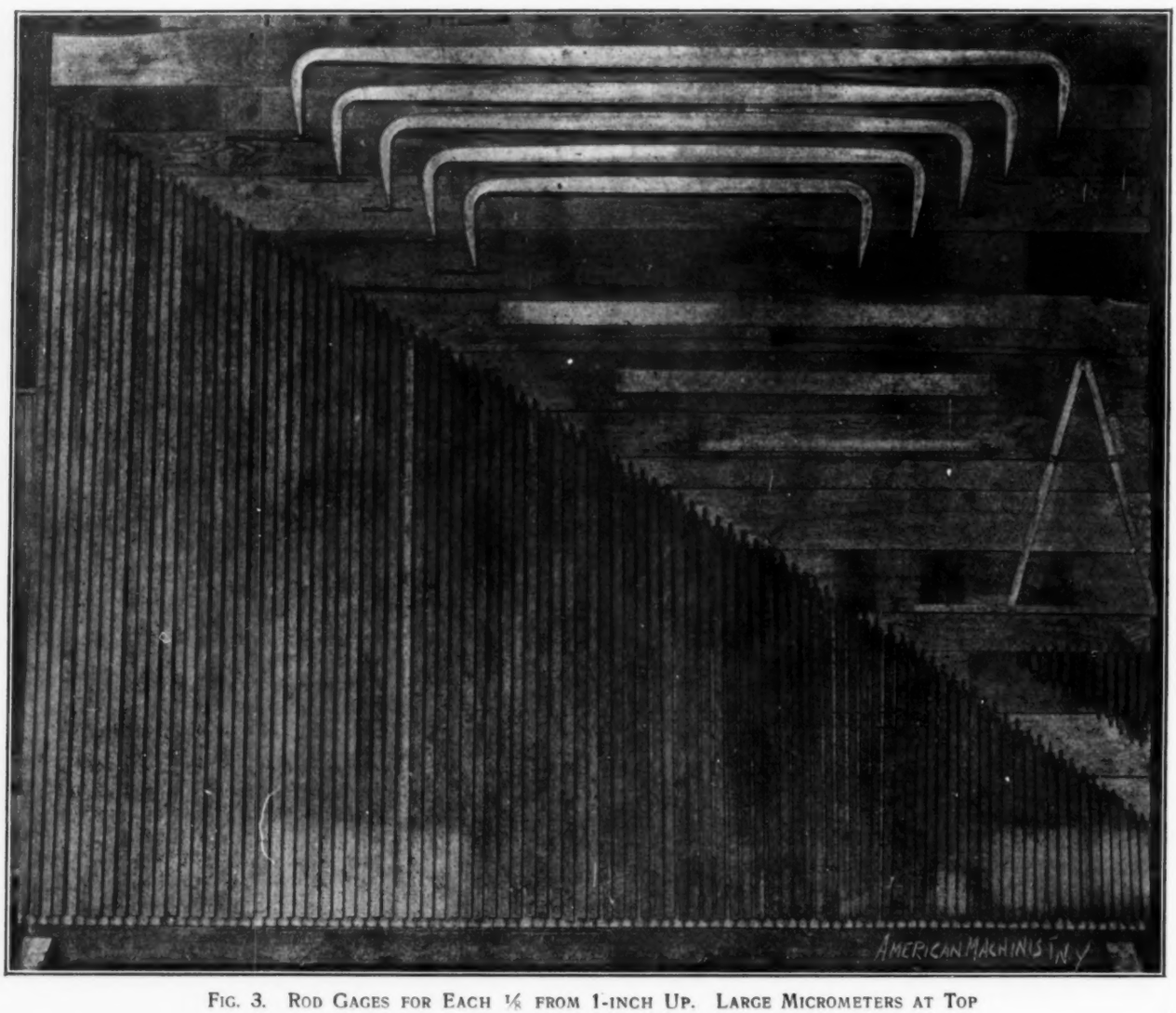


FIG. 3. ROD GAGES FOR EACH ⅛ FROM 1-INCH UP. LARGE MICROMETERS AT TOP

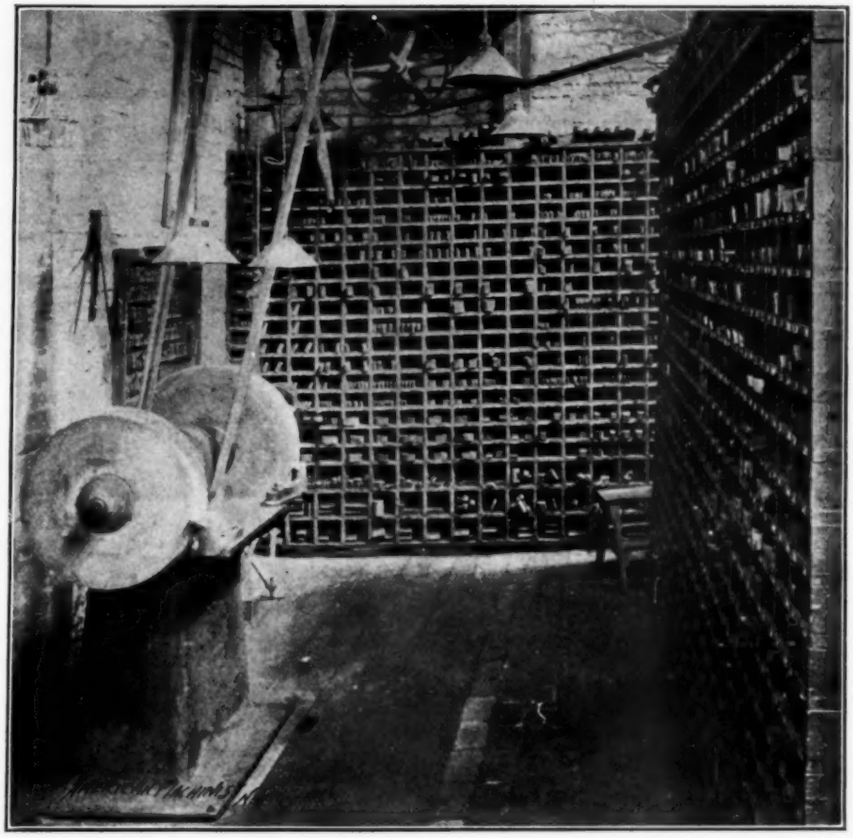


FIG. 5. CUTTING-TOOL RACKS AND EMERY WHEEL

shown in Fig. 4, which also shows the motor-driven toolmaker's lathe. The usual custom with a great many has been to place the tools in pigeon holes just large enough to hold them, with the result that merely the end of the tool could be seen, and many times this caused the tool-room man to pull out a number of tools before he could see which was the correct one.

This system has been altered in the tool racks herewith shown, and as will be seen, each tool is in plain sight so that the tool keepers can tell at a glance the tool that is required without going over a list to find the correct number of the pigeon hole. The tools are checked out in the same manner that is now almost universally adopted, which is that of hanging the mechanic's check on the rack from which the tool is taken.

CUTTING TOOL RACKS

In Fig. 5 is shown the corner of the tool room that holds the lathe, planer and shaper tools, and these are placed in the rack with the cutting edge out, so that the shape and kind of tool can be plainly seen. In front of these racks is placed an emery wheel, and the tools are ground as soon as brought in, so they will be ready for use when called for. These tools are ground to a standard set of shapes, clearances and angles, as is now the generally accepted custom in many shops.

CLAMP RACKS

In Fig. 6 is shown a rack for clamps, which is contrary to the usual system of throwing them around the shops, or rather the entire lack of system of having a place for them. As will be seen, the different sized clamps are arranged in a row in a rack and above them are hung the bolts that are used. As will also be seen, all the different lengths of bolts that are required for the work in this particular shop are kept here. This rack is outside of the tool room, but immediately in front of it. No checks are needed to get the clamp, but they can be taken by the mechanic as required. The foreman, however, insists that they be brought back to place when not in use and not left lying around the shop. Above this will be seen a rack for the very large files which are used in the machine shop.

E. F. L.

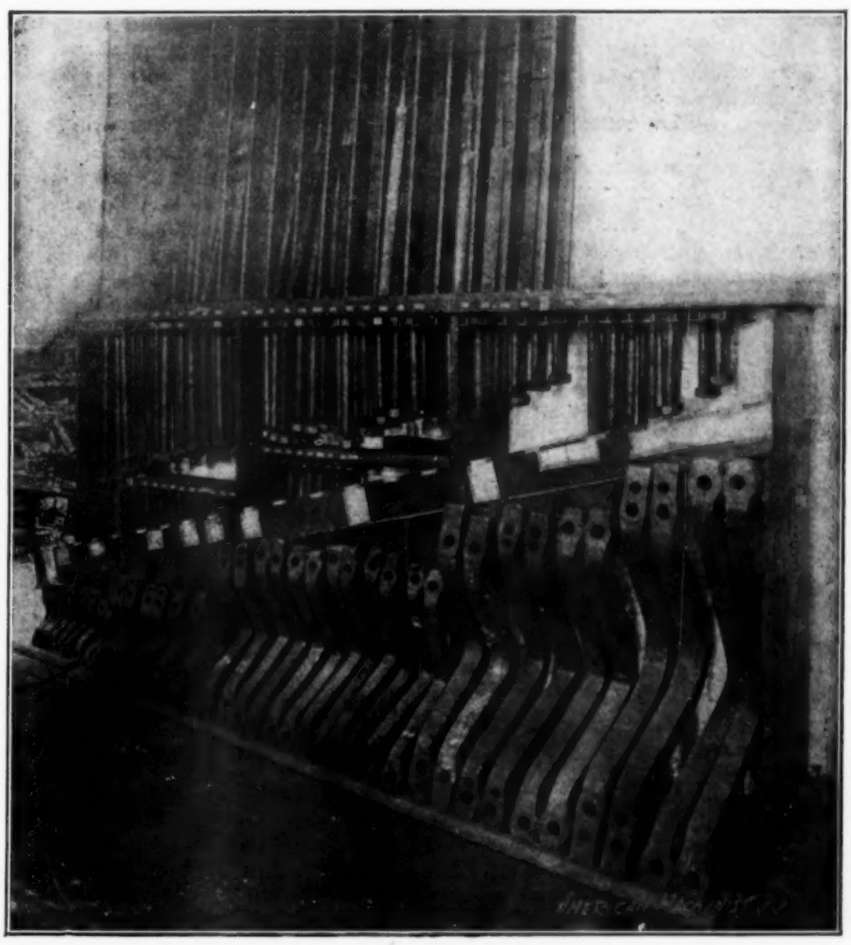


FIG. 6. RACK FOR CLAMPS

From tests made at the Watertown arsenal in order to determine the strength of steel at different temperatures it is noted that at 400 degrees Fahrenheit a test bar showed a tensile strength of 75 tons per square inch, whereas at 1600 degrees Fahrenheit the tensile strength was reduced to about 10 tons. Other tests showed similar results which pointed to the fact that iron and steel attain their maximum strength at from 400 to 650 degrees Fahrenheit and when this is exceeded the strength falls rapidly.

Pattern and Mold for Chilled Capstan Bell

By W. Potter

The advantage of chilled castings is so well known that further comment is needless. The only question that troubles most is the cost of the chills to obtain the effect. Some are simple enough and cost so little that the advantage to be gained by their use so far outweighs the cost that it pays to have the chill made even where it has only to be used for one casting. On the other hand, it may be necessary to closely estimate the advantage as compared with the cost; the question of renewals owing to cracks, distortion, etc., must be taken into account even where a number of castings are required.

Another determining feature of chilling is the form of the casting to be chilled; for instance, it is obviously impossible, under ordinary conditions, to chill a casting that has projections at right angles which would interfere with the contraction. The subject of this article, however, is one of those which are comparatively simple, and although the chills, etc., appear to be somewhat expensive to make, the return amply justifies the outlay.

It was at one time, and is no doubt in a number of places still, the practice to cast these bells in two portions, the top part being cast in a chill, and then made to screw into the bottom part, which is cast in an ordinary sand mold. This is shown in Fig. 1. The idea is that as the top part gets worn, through friction with the rope it may be taken off and renewed, thus saving the bottom part and avoiding the expense of molding and machining a complete new bell.

It has been found that this idea does not always work out in practice, for if long in use, or exposed to moist or sea air, they get rusted up, and the two parts cannot be separated without breaking the bottom. Again, it will be found that where only new tops are required the cost of separate castings and machining show very little, if any, economy.

After taking everything into consideration it was decided to ascertain the results from making them in one casting as in Fig. 2, using a combined chill and molding box. After a few trials that proved more or less satisfactory, a suitable casting was turned out, and the present practice adopted.

One of the failures was due to the casting cracking all round at the junction of the chilled part with the sand portion. This must have been owing to the presence of the four ribs *A*, which were at first cast in to strengthen the bottom of the rim, and we had no further trouble in that respect when they were left out.

Only the portion between *B* and *C* is chilled, and Figs. 3 and 4 show how the pattern for the chill body is made. Two half-octagon pieces of lumber about 2 inches thick are cut out and then lined up with staves the full length of the required casting. This is made to the smallest diameter.

Pieces of the shape at *D*, Fig. 3, are cut, and fixed to one end of the pattern; note that it is not necessary that these should be placed close together, as the spaces can be filled with sand by the molder.

The bolt lugs *E*, Fig. 4, which must be left in the sand until after the main pattern is withdrawn owing to their position, are fixed on with loose pins that are taken out when sufficient sand has been rammed around the lugs to keep them in position. After fixing on the bolt flanges and swivel-pin boss the pattern is complete.

The core is made in the box, Figs. 5 and 6; this box is made up with a bottom and two sides, the half circle being formed with the strike board *F*.

Referring to Fig. 17, it will be seen that ribs are cast in the part of the mold that is to be filled with sand. These ribs are necessary to keep the sand from falling out as the chill is heated to a comparatively high temperature. The projection *G* on the strike board *F* forms a recess in the core in which the ribs are set after the core has been formed; it will also be noted that they are slightly dovetailed and must be withdrawn after the core is taken out of the box.

The mold for the bottom part *H*, Fig. 7, is made by means of a sweep board, shown by Fig. 9. This board is shown raised above the mold, so that the bolt lugs and swivel-pin dummy can be seen. They are fixed in their respective positions in the sand as the mold is being swept up, so that these lugs and dummy pins can be withdrawn, and to allow the round bolt cores *I I* and wrought-iron pins *J*, Fig. 10, to be inserted. A pocket joint is made over each piece; then a plain cope is all that is required to complete the mold. As this bottom casting also forms the seating for the core *K*, Fig. 7, means must be provided for venting; this is done by coring four 2-inch holes through the bottom.

The top part *L*, Figs. 7, 8 and 13, is made in a somewhat similar way, but in this case the sweep board *M*, Fig. 11, is first used to make the bed on which is placed the frame, shown at Fig. 12. *M*, Fig. 11, shows it in position; this frame is to form the ribs *H*, Figs. 8 and 13. The mold is then completed by filling up with sand and finishing off with the sweep board *N*, Fig. 11.

Fig. 14 is a dummy plate, the top part of Fig. 13 is placed on this, to be rammed up with sand so that it will form the top of the capstan bell, as shown at *L*, Fig. 7. In this case a level bed is made with the plain edge of the sweep board *O*, Fig. 15; the bars *P P*, Fig. 14, are set in position on this bed, and the cope rammed up on it; after removing the cope the other edge of the board is used to form the mold for the plate.

A half plan and sectional elevation of the cast-iron pattern that is used for forming the bottom part of the bell is shown in Fig. 16. The use of this casting is shown in Fig. 22. The sweep board *Q*, Fig. 16, is used to form the outside of the mold; the inside is made by means of a pin board. As a core, this is shown on the left hand of Fig. 17. The pieces *R R*, Fig. 16, which are cast in for lifting purposes, are set in position on the bottom of the plate. The right hand of Fig. 17 shows half of the complete mold with the core in position ready for casting.

The making of cores by means of a pin board is worth special mention as the variety of work that may be done on it is so great, and at the same time economical. We have found it so useful that a special spindle and cast-iron plate has been made in place of the ordinary wooden ones that are usually provided.

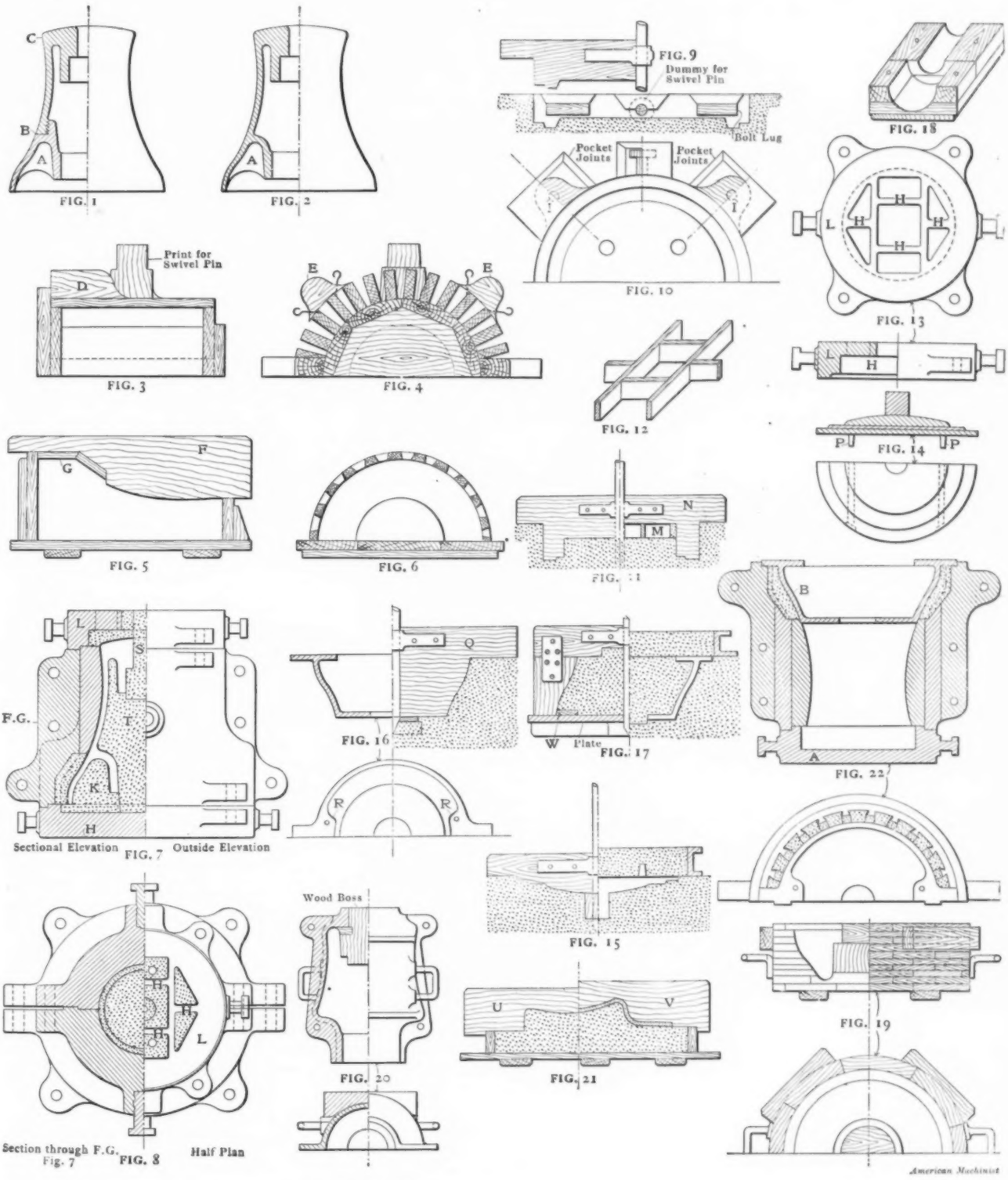
Fig. 18 shows the half of a core box for making the core *S*, Fig. 7.

Fig. 19 shows the construction of the box for making the core *K*, Fig. 7. The wrought-iron handles fastened on each side of the box are found to be very useful.

Fig. 20 is a cast-iron box for the core *T*, Fig. 7, and the pattern is made with loam in the following manner: The strike board *U*, Fig. 21, working on two ends that are fixed on the plate, forms the core; after the core is dried the extra thickness of loam which corresponds to the thickness of metal required is struck on, and formed by means of the board *V*. The flanges and bosses for the handles are fixed on in the usual way. After the mold has been made the extra loam is stripped from the pattern, and then the core, after being blacked, is ready for use.

To prepare the mold for the cast, the

two halves of the chill are set onto the bottom part of Fig. 17, and bolted together; when putting in these bolts it will be found necessary to make provision for the sudden expansion of the chill, which takes place when the metal is poured in, otherwise either the bolts or the bolt lugs will break. We have found that wood washers $\frac{1}{8}$ inch thick, acting as a cushion between the nut and the casting, answer the purpose very well. The cast-iron pattern *W* is now fixed on the top of the chill and sand-rammed all around; this is plainly shown in Fig. 17. This pattern is then withdrawn, and the mold made ready for the stove. Next place the top part *L*, Fig. 13, onto the plate, Fig. 14, and ram up, at the same time making preparation for the pouring gate and risers. This top part is also put in the stove. The mold put together complete and ready for casting is shown in the sectional elevation, Fig. 7.



PATTERNS AND MOLD FOR CHILLED CAPSTAN BELL

MACHINERY in JEWELRY MANUFACTURE

The Evolution of Bullion into Gold and Plated Ornaments

BY E. C. BLISS *

Under the head of jewelry, all ornaments are placed, not only by the jeweler himself, but by the purchaser who goes to the retail store to buy a pin, brooch, cuff button, chain, watch, or a wedding ring. However, like all industries, jewelry has its specialties, just as the machine toolmakers may be divided into several branches: the milling-machine maker, the planer maker, maker of grinders, and other special machinery makers too numerous to mention. So in the jewelry industry we have the maker of gold jewelry, the silversmith, the chain maker, the maker of cuff and collar buttons, the brass-jewelry maker, and the plated-jewelry maker, besides a long list of others, each taking up some special line and each selling to a separate trade.

Silversmiths are, no doubt, the largest manufacturers who come under the head of jewelers. Silversmithing, as a trade, is the making of what is known as hollow ware (urns, bowls, loving cups and articles of like nature), and flat ware (forks, knives, spoons and ladles, or table silver in general). Some of the larger concerns make a line of jewelry also and indeed such plants as Gorham's in Providence, R. I., or Tiffany's, in Forest Hill, N. J., both known as silversmiths, make some very beautiful and costly pieces of jewelry.

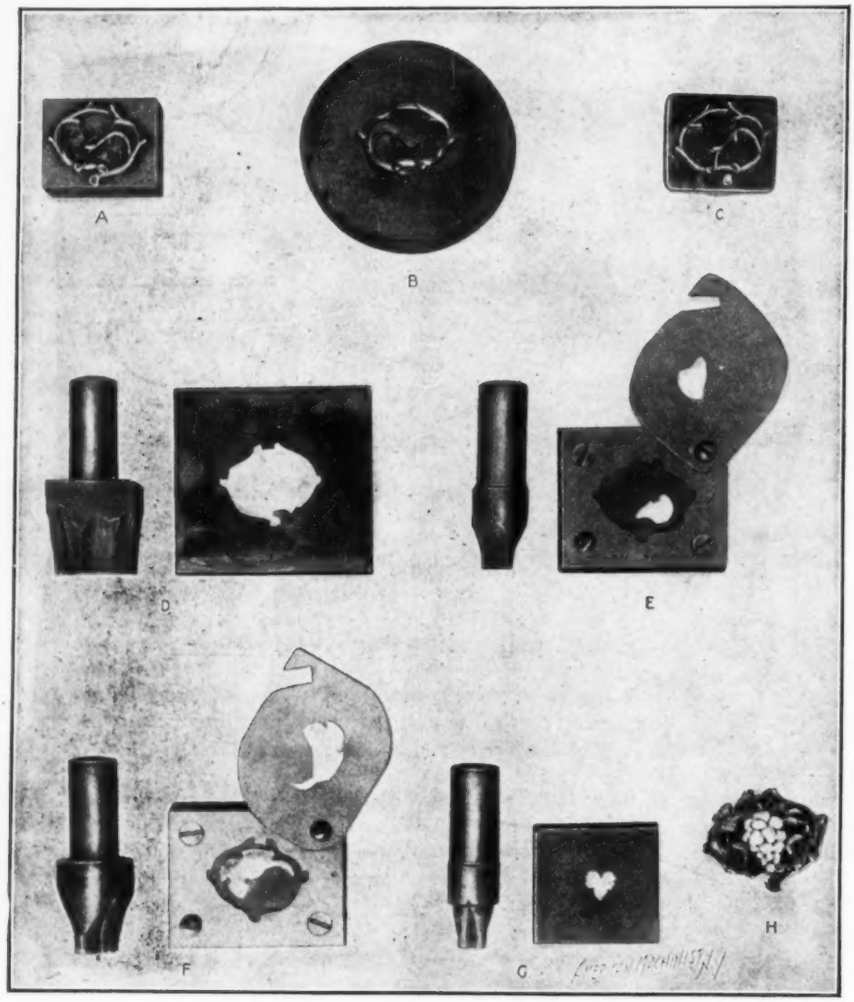


FIG. 1. CUTTER PLATES AND PLUNGERS FOR FORMING JEWELRY

From the gold-jewelry manufacturers, we are able to get an idea of what a jewelry factory is like. Here we can see the gold from the time it comes from the bank until it is shown in the finished product. The gold is purchased from the bank in small ingots measuring approximately three inches in length, 1½ inches in width and from ⅝ to ¾ inch in thickness with the Treasury seal upon it. Such a piece costs anywhere from $500 to $1200, depending upon the size. This ingot, by means of rolling mills, is rolled down into a ribbon and is then cut up into small pieces for alloying. The gold used for 12-carat work has something like 50 per cent. of other metal added to reduce it from 24 carat to the required alloy. For alloying, silver, copper and Wessel metal are used, depending upon the color wanted, for 12 carat may be a green gold, a red gold, or a white gold, according to the alloys used and the amounts of each. After the fine gold is weighed out with the alloy, it is placed in a crucible and is all melted and poured into an ingot mold and then rolled down, with intermediate annealings to the thickness desired.

AN EXAMPLE

As an example of work, take the small pendant illustrated in Fig. 1, at *H*. Small pieces are cut by shears from the flat stock and stamped up or in other words embossed by the use of a small hammer, similar to the one used in drop forging. These pieces are then brought up in a steel die in which the die sinker has cut out and engraved the design to be used. The die *B*, Fig. 1, is cut with the design depressed or made female; the force or steel male hub *A*, Fig. 1, is cut away enough so there is room for the stock between the force and the die. The work, *C*, Fig. 1, is then taken from the drop to the press (for thin work this is generally a foot press), and with a punch and die, known among the jewelers as the cutter plate and plunger, is first clipped (*D*, Fig. 1), then pierced (*E*), pierced again (*F*) and then taken to the jeweler or bench hand for assembling. The bench hand first cleans off the parts, so there will be no grease nor dirt to prevent the solder from running easily. Next, he proceeds to assemble them, soldering or brazing the different parts together, using gold solder; then he gives them to the polisher who cleans them up and gives a slight deposit of gold in the electroplating department which is known as shading, to make the color uniform. Otherwise, a dozen pieces of the same alloy would show a slight difference in color, caused by the heat in the soldering operations.

From the coloring room, so-called, the

*President, E. C. Bliss Manufacturing Company, Providence, R. I.

pieces are given to the stone setters and engravers who proceed to engrave and mount the stones. The finished article is then ready for the shipping room to be sent away to the wholesale jeweler, the retail jeweler, and the consumer.

Designs come from various sources, many being copies from other producers. Some factories have their own designers while others have to depend on their hub cutters and die sinkers for their designs. Then again, a few are copies of French articles, that nation leading all others in style. The jeweler has much to contend with in the matter of style, for an article that is one of this year's best sellers will, next year or two years from now, be obsolete. It would surprise many who are unfamilar with the work to know the great amount of money tied up in dies, tools and fixtures, the greater part of which cannot be used again.

Rolled Plate

This is an article very little known outside of the jewelry trade. Prompted by the inquiries of a number of people who have asked if it were dipped or washed, I will try to describe the different forms in use. Rolled plate, as its name signifies, is a plate rolled on. A strip of stock of the carat wanted is brazed or soldered onto a piece of composition metal known as platers' metal which looks like and is composed mostly of copper. This is then known as an ingot, the thickness of the gold soldered to the base metal determining the quality of the stock, such as ¼, ⅛, 1/10, 1/15, 1/20 plate. In ¼ plate, one-quarter of the weight of the ingot is gold. After the gold is brazed on, the stock is rolled out to the desired thickness and then follow the operations similar to those described in the making of gold jewelry. Care must be exercised in the making of plate work, not to file off too much of the gold for then the brass or platers' metal would be liable to show through. Even a polisher, if incompetent, can very easily polish off all the gold.

Rolled-gold jewelry is known by a number of different names, as in the instance of watch cases, some 15- year, 20-year or 25-year cases, which are nothing more than rolled plate, the other names being gold filled, rolled gold (a rather misleading term), rolled gold filled (another name used to mislead the purchaser), gold front and plate.

Wire Making

To take up the making of wire; after the plate is rolled out as thin as required, it is cut up into narrow strips and drawn down through a draw plate which makes a seam tube. For a soldered seam, a strip of thin silver or gold is placed in the seam and brazed or soldered. This is known as soldered tubing. After it is soldered, the tube is drawn down into wire the size desired.

Next comes the gold filled or seamless wire which is made with the plating metal and gold but in a different way. The gold is drawn up into a shell similar to a cartridge, then is drawn and a piece of plater's metal is inserted and brazed. These ingots vary as to length and diameter, although we can take one 1½ inches diameter and about 8 or 10 inches long. The first step in the making will be the breaking down process, accomplished by a reducing machine which is made similar to the well known pin-pointing machine but large and strong enough to reduce this ingot by means of different dies to the point where it can be taken to the draw board to be drawn through dies, with annealings, until we get down to No. 8 or No. 10 Brown & Sharpe or 0.128 inch to 0.101 inch. It is then placed on continuous wire drawing machines which take it down from the above numbers, leaving the last die about No. 20 or No. 25 Brown & Sharpe.

We now have the rolled plate (this may also be double plate, gold on two sides of the ingot), the open-seam wire, the soldered-seam wire, and the seamless wire, so we can make almost anything wanted in either the jewelry or chain line. Before taking up the manufacture of chain, requiring special machinery, we will first mention the manufacture of the cheap jewelry.

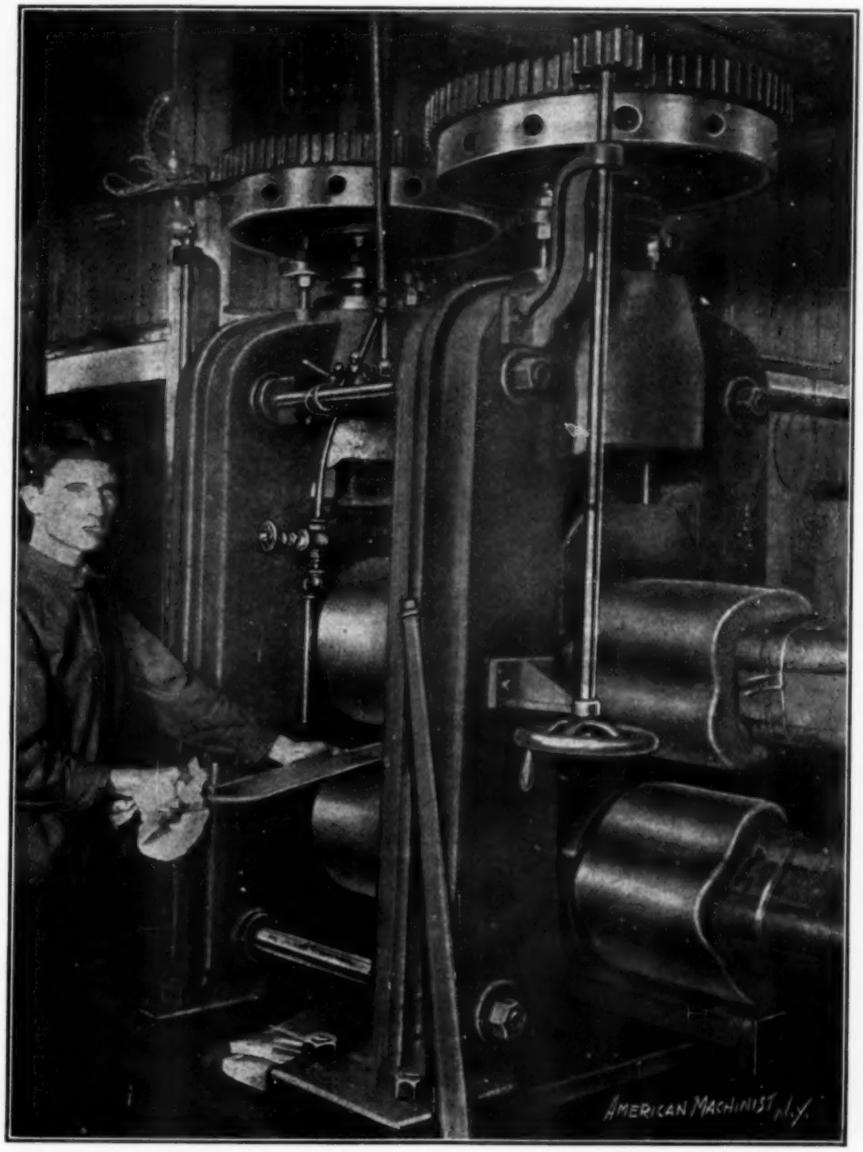


Fig. 2. Rolls for Breaking Down Sterling Silver Ingots to Form Sheets

Cheap Jewelry

This is made mostly from brass, either high or low, and I understand some steel is used by many manufacturers. It is needless to say that the operations are somewhat similar to those required in the making of gold jewelry but more money is spent on tools and special machinery with the cheap brass line than is expended with the gold work, for in the latter case the work is done mostly by the jeweler.

The cheap-jewelry factory uses many machines and tools similar to those in

operation in the larger brass cutting up factories such as the roller feed, power press, eyelet machine, used for making settings, dial presses, the drop presses spoken of in making gold jewelry, screw presses and foot presses. These latter machines are used on the better quality of brass jewelry which is brazed or hard soldered, using either silver or brass solder, the cheaper being soldered by soft solder or as one jobber put it, he wanted stuff soldered, not "frozen together." However, it would surprise one to see the beautiful work turned out by the cheap-jewelry factories.

After the jewelry is made, it is colored or electroplated and either gold or silver deposited on the work.

There are also many special machines in use in the cheap-jewelry factory, depending upon the work or line made and

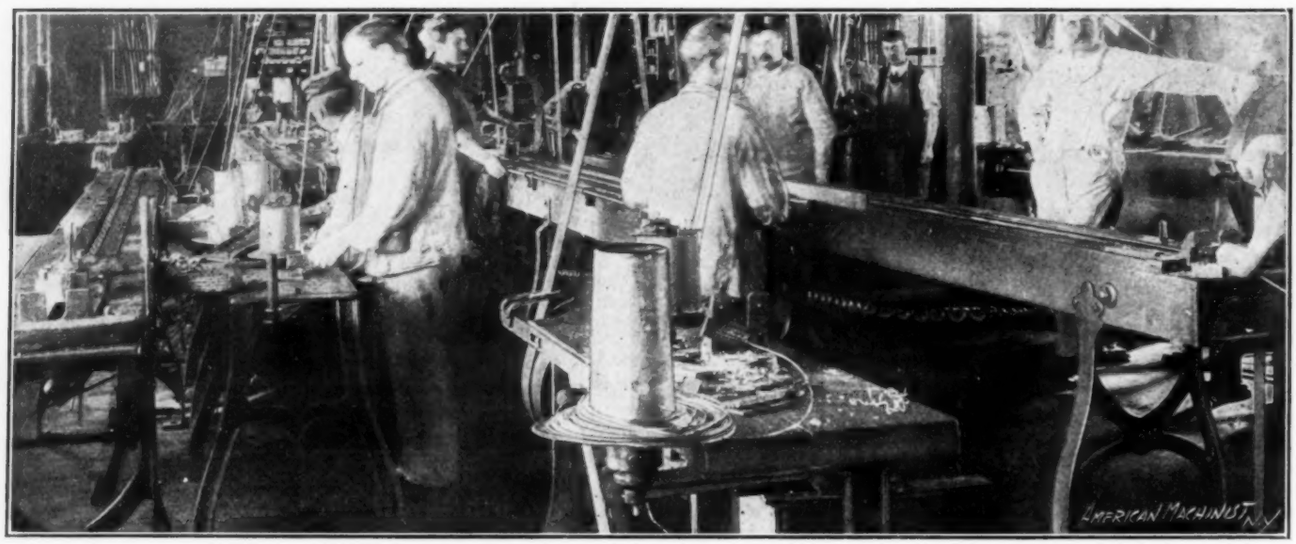


FIG. 3. DRAW BOARDS FOR LARGE SIZES OF WIRE AND SMALL SIZES OF TUBING

I have in mind a factory in Providence which has machines for making "beauty," or small one-piece pins, which takes the wire, embosses or stamps an artistic impression upon it, bends it, and joints it, at the rate of 130 pins per minute. The finished product is dropped into large ash cans. Another machine used is the ring machine which takes the wire, cuts it off, forms it up into the ring and drops it out of the bottom of the machine all ready for soldering. Then come the machines for making that very much abused but necessary article, the collar button. These are made by automatic machines which are jealously guarded by the different manufacturers who own them.

CHAIN

Having taken up the manufacture of jewelry, a few words may be said about the making of chain. The wire is taken from the wire maker, known in the jewelry factory as the plater, and in the case of small eye-glass chain, the wire is drawn down as fine as 0.009 inch, placed on an automatic chain machine and made up into chain at the rate of 250 links per minute; in the case of the 0.009-inch wire, 32 links to the inch. This is at the rate of 400 feet of chain a day. Next, the chain is cleaned off and given out to the girls to be soldered. The first step is the turning of every other link so that the joints of two links come together. A small piece of solder is then placed upon the point where the joints meet. The solder used is about 0.009 inch round and 0.006 inch long and is cut on small automatic machines.

After the chain is soldered, it is cleaned off, cut up, assembled, shaded, or electroplated to make the color uniform, carded and shipped.

This same chain may be worked up into another form or taken from the solderers and curbed or twisted so it will lie flat. This is done on a small curbing head.

DEPENDENT INDUSTRIES

Besides the jewelry factory, we have very necessary special supply factories for the manufacture of some specialty such as the hub and die cutter, the pin and joint maker and the setting maker. The two latter come under the head of jewelers' findings, which title includes also a large line of ornaments and other articles necessary for the manufacturing jeweler.

Other lines depending upon the manufacturer for orders are the rolled platers who make gold-filled wire and gold plate, silver and gold wire, and wire and flat stock from other precious metals; the colorer or electroplater, who takes in work from the smaller factories which have no facilities for this work; the bar and swivel maker, the man who makes nothing but chain findings, the machine chain maker, the refiner who takes the sweeps from the floor and the settlings from the water used to wash up, together with polishings and buffings, and refines them. It may be mentioned here that it would surprise many to know the amounts returned to the jeweler from these waste sources alone. Polishings from a medium sized shop bring in $500 per year, the sink $300 to $500, and sweeps from $10 to $100 to the barrel.

THE TOOLS USED

From the foregoing, it will be seen that many of the machines and tools used in the manufacture of jewelry are familiar ones to the ordinary mechanic; the tools, however, are much smaller than would be required in regular work. Very few machines are made special, especially in the gold line above spoken of. In the jewelry tool room, employing between 50 and 100 men, where the tools are made, there is very seldom more than a small lathe, 14-inch or 16-inch, a 15-inch or 20-inch shaper, and a Thurston mill used for making the cutter plates or punching dies. As this machine is not often seen outside of a jewelry factory, it might be well to describe it briefly. The Thurston milling machine has a vertical spindle, driven from below by bevel gears, and the work is held by clamps upon the top of the machine. The clamps or jaws are on one side with a movement across the machine, operated by a small hand wheel, this in turn being operated on a slide at right angles to the first, by another small hand wheel. By this means one can follow a line very easily and not only follow it, but see it, which is a difficult thing to do on the regular milling machine.

Other machines which are used are drops, power presses, screw presses, foot presses, rolls, sensitive drills (used by

the jewelers and stone setters) small speed lathes for sawing the metals, winding links, and milling or what is called burring; lap wheels which are used to lap the work, polishing heads, exhaust fans, small dynamos for electroplating, and the dies.

In the chain shop we find the chain machines, solder cutters, link winders, link machines, dial presses, power presses, small rolls for rolling chain, curbing heads, together with the apparatus necessary for the finishing department.

For the making of rings, collar buttons, and other staple lines, the machines of the regular jewelry factory will be found but in different sizes, consistent with the work made.

Thanks are extended to the United Wire and Supply Company for the photographs from which the accompanying halftones were made.

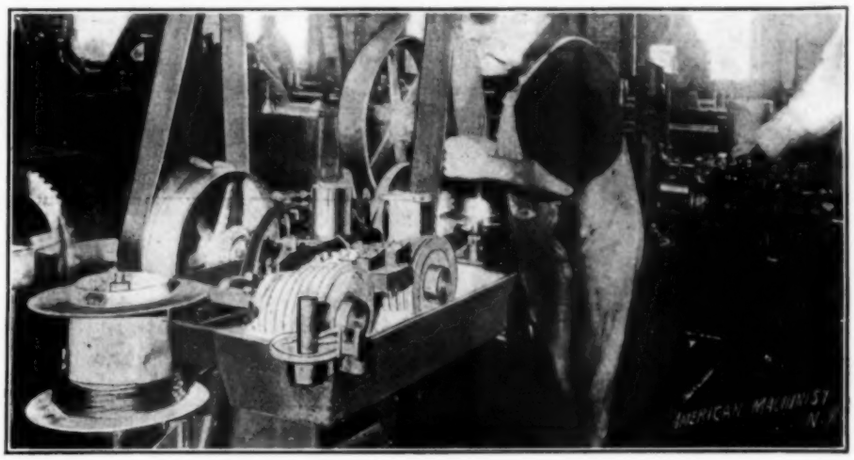


FIG. 5. A CONTINUOUS WIRE-DRAWING MACHINE THAT WILL TAKE 10 DRAW PLATES AND REDUCE THE WIRE 10 NUMBERS

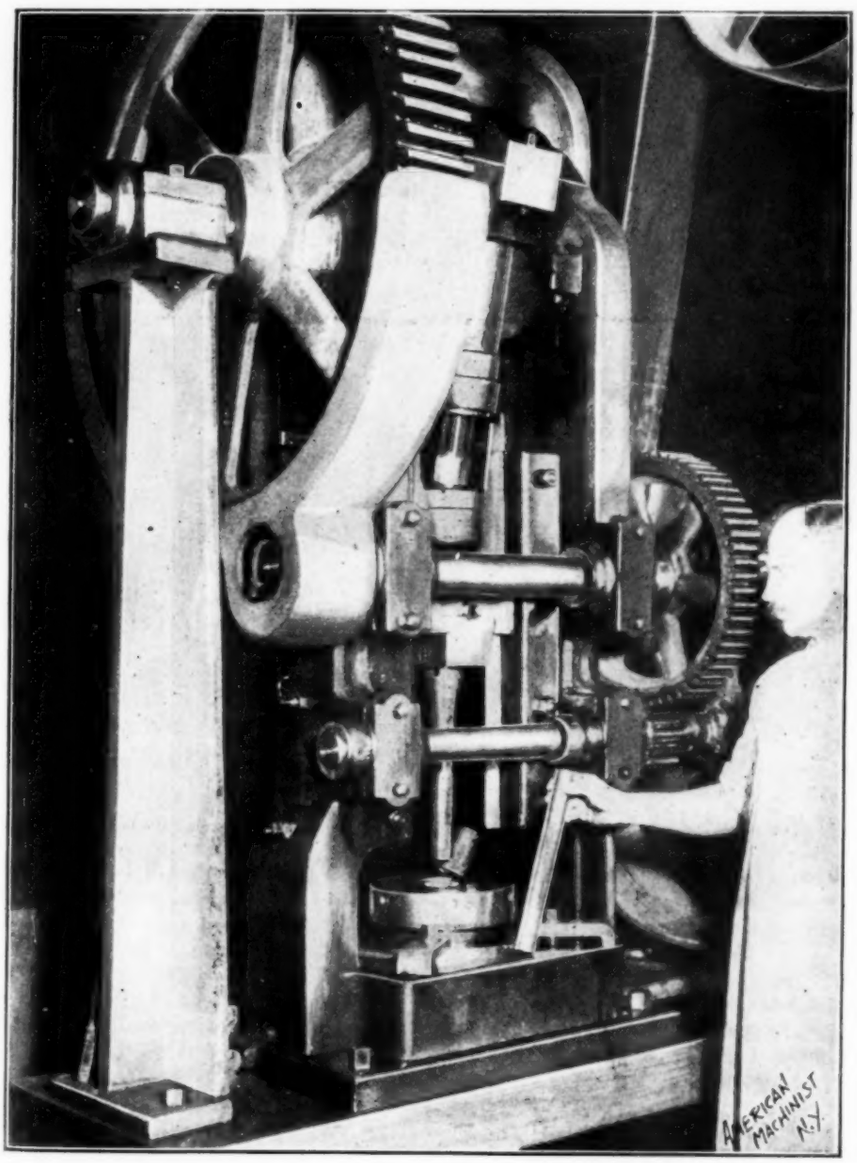


FIG. 4. LARGE DRAWING PRESS TO DRAW GOLD SHELLS FOR MAKING SEAMLESS GOLD-FILLED WIRE

Those Expensive Taper Pins

BY A. H. ADAMS

Do you ever wonder how you can make those small taper pins more cheaply? You use thousands, perhaps, and they must have enough taper to drive well. Just biting off a wire isn't good enough and special watch machinery for the purpose will cost a lot, and makes the pins expensive. They are also expensive made on the automatic screw machine. Maybe you are buying them.

Did you ever try knocking out 60,000 or so a day on a *solid die*, double or single stroke, heading or rivet-making machine? The small end will have a slight depression, made by the knockout pin; the big end will have a fin; but they can be made *so* cheap, and can have just a nice taper for driving. You file or mill, or grind them flush anyway, so the fin doesn't matter.

A Striking Use for Old Files

Having occasion to visit one of the cheap restaurants in the neighborhood of the docks I was struck by the somewhat novel match-strikers fixed up in various places. On examination I found they consisted of about 4-inch lengths of old flat files, and were fixed to the woodwork with two button-headed screws through a hole at each end.

I cannot tell who the genius was who made this striking discovery, but I found out that the late proprietor was also a blacksmith. The old fellow at present in charge spoke very highly of their usefulness, and also explained that "when worn out they can be reversed as *both holes* are the same distance apart."

A Speed Indicator Testing Machine

By Dr. A. Gradenwitz

The familiar hand tachometers provided with centrifugal pendulums or an element deflected by vortex currents, have been found to be very practical speed gages for determining the average velocity of rotating machine parts during short intervals. In order, however, to use such instruments in connection with scientific research work, means should be provided for testing their behavior at any time by a simple process.

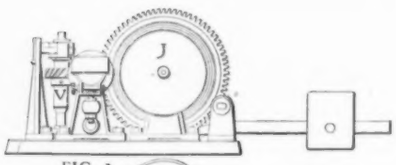


FIG. 1

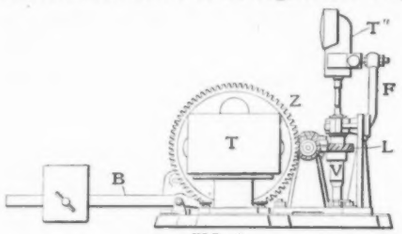


FIG. 2

American Machinist

DIAGRAM OF GERMAN SPEED-INDICATOR TESTING MACHINE

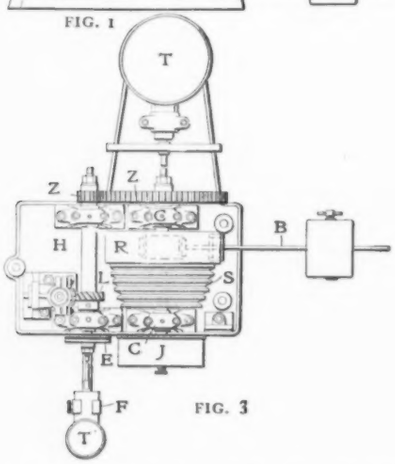


FIG. 3

Prof. A. Wagener, of the Danzig high school, in conjunction with M. Bliss, recently constructed such a testing device for speed indicators which has been in use for some months at the mechanical laboratory of that school.

As seen from Figs. 1 to 3, this outfit comprises a main shaft supported in *C C*, which carries a flywheel *R* with a stepped grooved pulley *S*, susceptible of being driven at five different speed ratios from a stepped pulley mounted on the shaft of an electromotor. To one of the ends of the main shaft can be coupled directly a speed meter *T*, the scale of which is divided into angular degrees. The point of the speed-gage pointer consists of a very thin membrane vertical to the scale. A mirror placed below the dial allows any parallaxis to be safely avoided, thus allowing tenths of a degree to be read with fair accuracy. The other end of the main shaft carries an indicator drum *J* on the paper of which an electromagnetical stylus registers the picture of a damped vibration, allowing the average speed of rotation of the main shaft for a very small interval (as given by the known duration of vibration of the recording lever) to be determined with close approximation. As the aluminum stylus is pressed against the drum a stop strikes the point of a set screw, thus causing the current to be thrown through the magnet coil so that the excitation occurs immediately after the contact between the stylus and paper has been made, causing the vibration curve to be registered. Any velocities corresponding to the various positions of the speedmeter pointer can thus be ascertained, so that the speed indicator can be used as a standard instrument in testing any hand tachometers.

Speed Range

As, however, its speed range, which extends from 240 to 1040 revolutions per minute, is far from comprising all the numbers of turns occurring in general practice; an auxiliary shaft *H* connected to the main shaft by a toothed pinion *Z*, has been provided, the four pairs of toothed wheels allowing the following ratios of transmission between the main and intermediary shafts to be established: 1:6, 1:3, 1:1, 2:1, 3:1, 6:1. The speed gage *T* is fixed on a rotary foot enabling it to be turned aside after loosening the coupling. Furthermore, the stepped pulleys mentioned allow the following five ratios to be approximately obtained: 1:1.5, 1:2, 1:2.5, 1:3, 1:3.5.

Again, the number of turns of the electromotor, as seen from Fig. 4, can be altered by a regulating resistance and a lamp resistance in the field coil, between about 850 to 1500 revolutions per minute, thus yielding a range of variation of about 45 to 6000 in the number of turns of the intermediary shaft. These limits thus allow any given speed to be obtained at least once. A brake *B* provided with a running weight which acts on the flywheel is used, in special cases, to effect an alteration in speed between close limits.

In using this testing outfit, the end of the intermediary shaft *H*, which is situated at the point of attachment of the toothed pinion, is generally left disengaged; this allows average numbers of turns to be determined very easily by means of a speed gage applied by hand, care being taken to keep approximately constant any average number of turns once adjusted for, which is readily obtained for intervals of sufficient duration. To the other end of the auxiliary shaft is connected any hand tachometer (namely, the speed gage *T'* in Fig. 3) that is to be tested.

A current-supply disk *E* mounted at the same end of the auxiliary shaft serves to excite frequency gages of the Frahm system, which accordingly can also be tested by the same outfit.

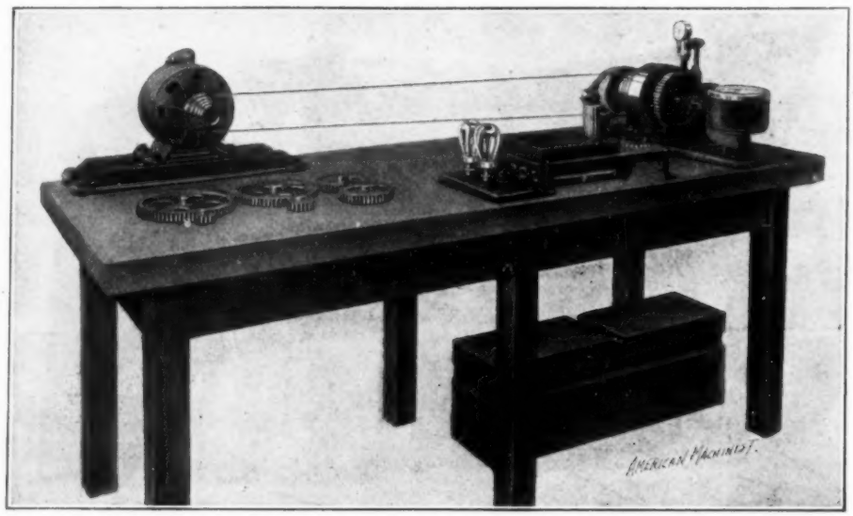


FIG. 4. SPEED-INDICATOR TESTING MACHINE AND DRIVING MOTOR

To the auxiliary shaft *H* is finally coupled a vertical auxiliary shaft *V*, through a gearing consisting of two identical worm wheels. To the upper end of this shaft can be connected any tachometer desired—mainly those which can be used only in a vertical position such as, for instance, the well-known bi-fluid tachometer. A special recording device identical to the one above referred to, allows a large number of vibrations to be registered on a recording tape. The special design of these indicators renders the main recording device readily accessible to the action of an electromagnet and by exciting this with a clockwork or contact pendulum, a number of time markings are obtained which are registered by the main recording device besides the vibration curves. The diagrams thus indicated afford a means of ascertaining the frequency of those resilient recording levers which are used with investigations of this kind or in connection with indicators. In fact, their possibilities are many, and the results so far obtained are highly satisfactory.

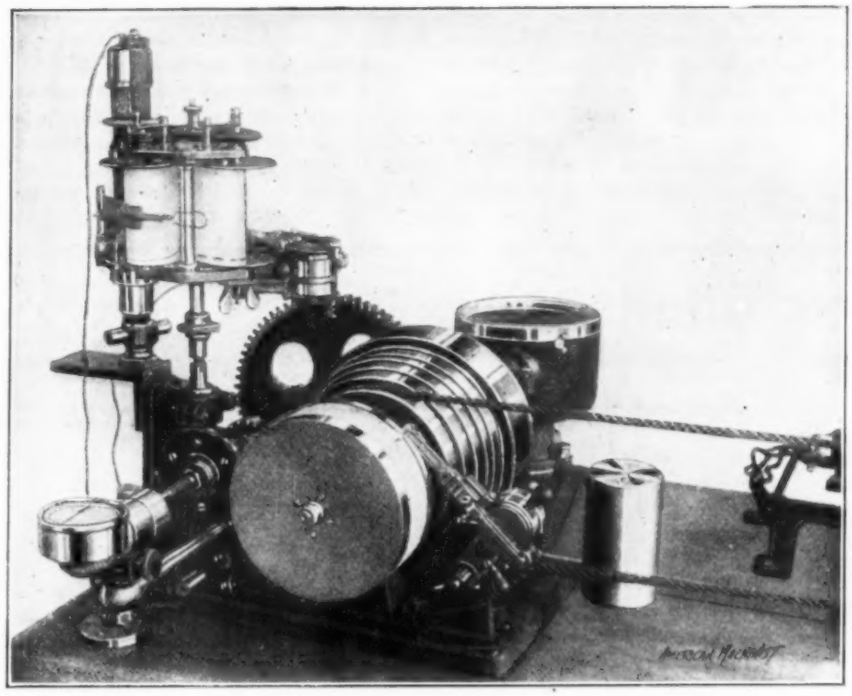


FIG. 5. GERMAN SPEED-INDICATOR TESTING MACHINE

POINTS TO BE CONSIDERED IN TESTING SPEED INDICATORS

In the testing of speed gages, the following points should be considered:

(1) The "degree of insensitiveness" of the tachometer which is the figure characteristic of the limits between which the speed may vary without imparting to the pointer any deflection whatsoever, may be different in a given instrument for different ranges of the scale and, moreover, is apt to undergo important changes in the course of time according to the variable condition of the tachometer. This insensitiveness is due exclusively to the friction resistances between the various elements of the gearing.

(2) Another defect of tachometers which is due to the inertia and damping of the gearing, is what Wagener terms the unpunctuality of the speed gage. By the damping of a vibrating system is generally meant the whole of the resistances to motion, which resistances are directly proportional to the speed, being of mainly molecular nature (such as, for instance, the internal resistance opposing any deformation of the spring, the resistance of air and the resistance of the liquid lubricant inserted between the elements of the gearing. The proportionality between the damping and the speed accordingly applies with safety only to small speeds as the resistance of air, for instance, is known to become proportional to the second, or even higher powers as the speed increases. Furthermore, there may be resistances at work which do not depend at all or only to a small degree, on the speed while exerting a damping action.

Annealing *By George Coles*

In all my 25 years' experience in different shops I have never found one of them to give sufficient attention to the annealing of tools. Everybody seemed to think that annealing, in some cases, was entirely unnecessary and in others a needless expense, as the results did not warrant the extra trouble and expense.

Speaking generally, annealing is one of the numerous methods of (indirectly) saving money. Cutting down costs is what everybody is looking for today, and to prolong the life of a tool is to save money.

Take a blacksmith's flatter, for instance. I know from experience that after using a flatter a short time it seems to crystallize, and in a short time a crack appears. The blacksmith wonders why it cracks, and simply says, "That steel is no good." Now, if the flatter is annealed the blacksmith will be surprised to find out how much longer it will last, and this is certainly saving money.

There are lots of tools that are used in a blacksmith shop that should be annealed. Flatters, as before mentioned, set hammers, fullers, swages, both top and bottom, cutters, punches, drifts, etc., all should be annealed once in a while. I used to anneal swages about once a month.

The tools in the above list, which is far from complete, are usually made of tool steel. There is, however, a good-sized list made of soft steel, such as tongs of various shapes and sizes, forming and bending tools of various kinds; all should be annealed occasionally. How often depends on the amount of work they do. Take steam-hammer tools, cutters, fullers, sets, tapering tools, offset tools, swages in particular, saddles, bolsters, collars and drift pins, all should be annealed, in that way eliminating danger from breaking to a great extent.

Then we come to tools in process of manufacture, such as reamers, milling cutters, taps, blanking dies and punches, gages that have been forged and are of reasonable size. They should be annealed most carefully after being rough machined all over to say 1/16 inch of size, thus taking away all the remaining forging strains. It will also lessen the tendency to spring and warp in hardening. I always make it a point to heat all tools that have been forged, and all others for that matter, to a dark red, or 1100 degrees, and hang them up by hooks or tongs to cool in the air. When cold I harden in the usual way. If you watch them closely you will find that the life of the tool so

treated will be prolonged enough to more than pay for the extra trouble. Try two reamers or milling cutters made from the same bar; harden one in the usual manner and heat the other as stated; when cold harden as is usual and note the results.

Then we come to tools used in the machine shop, which are too numerous to mention. All that are subject to strains and jars should be annealed.

Since the advent of the electric crane, chain slings have become a necessity and it is very important that these be annealed. Overloading and twisting of the chain causes crystallization and that can be overcome only by carefully annealing every week or two, as it is surprising how soon crystallization takes place again. To have a sling break and then put a link in the proken part does not make the sling safe by any means; but annealing will make the sling safe as it does in other work.

Trade Schools in Public School System

By P. Kreuzpointner *

The discussion by the committee on trade education of the Federation of Labor, at its recent meeting at Washington, indicates the introduction of a new factor into the present movement for the establishment of a system of industrial education. There can be hardly any doubt that the Federation of Labor will yield, at its annual meeting, to the economic necessity and join with the other social and industrial forces which have been active for some time in trying to bring about a solution of this modern educational problem.

If history is a guide for the judicious enactment of social and economic measures—and it is to be regretted that the study of comparative history does not receive more attention—then the industrial history of the Middle Ages down to the middle of the last century teaches us that there is neither a capitalistic, nor a workingmen's, nor business men's combination strong enough to resist for any length of time the irresistible pressure of economic forces. And it does not matter a particle whether it is the tenth or the twentieth century when such a change in the condition of the life of the people takes place. The outward form under which such changes take place may vary and does vary, but the results are the same, if in the readjustment of the social forces to the requirements of the new economic forces mistakes are made by those having the power to guide the readjustment, or if, on the other hand, by judicious foresight, the regulative actions which govern society guide this readjustment of social life into beneficial channels.

If we take a few leaves from the industrial and educational history of the sixth to the nineteenth century, we find that invariably those who ignored the demands for progressive measures, made necessary by changes in economic conditions of life, either were left behind in the struggle for existence, or, as sometimes happened, pulled down themselves and others to ruin.

Medieval Apprenticeship

It might be said that history has nothing to do with our present industrial situation and the problem of industrial education. Not so! The monasteries of the seventh, eighth and ninth centuries always tried to get the best craftsmen within the walls of their cloisters. The feudal lord who could count among his retainers skilful masons, swordsmiths, armorers, weavers, etc., considered them a valuable asset. In the medieval city the master or workingman who tried to pass off spurious or defective work for a first-class job was liable to have his ear or hand cut off, and not only was the father under obligations to teach his son all the secrets of his trade, but every workingman was obliged to travel as a journeyman for three years in different countries to perfect himself in his trade. The boy who had served his apprenticeship could not become a journeyman without passing a rigid examination as to his proficiency.

I learned my trade under the old medieval guild laws and when my time was out I had to pass an examination before three masters of the trade, a professor of chemistry and physics and a school teacher, besides being obliged to present for examination an object made by my own hands and drawings and other school work. There was great care taken by masters, workmen and municipal authorities to fit the education of the apprentice to industrial and economic conditions.

Having seen, experienced and been benefited by this care and attention to trade education, I may be pardoned if I express the belief that we have to be careful in not burdening our educational system with demands of a kind of industrial education which it cannot fulfil at present. I have always held, and have expressed myself publicly in reports, lectures and otherwise that nothing permanently useful can be accomplished along lines of trade or industrial training without the active participation of the public school in the work. Because of the absence of this coöperation of the school and industries, there is a great deal of economic and pedagogic waste resulting from the efforts of manufacturers, corporations, railroads and trade schools to meet the urgent necessity for more skilled men and for the municipality to get civic efficiency.

The Demand upon the Public School

To meet this urgent demand, too long delayed already for our best interests, there is a growing sentiment to look to the public school for specific trade education. But history, not foreign nor medieval history, but our own home-made history, does not favor the idea of making specific trade education a part of our educational system. A system of specific trade schools would be very expensive, especially in cities with diversified industries and would soon create dissatisfaction and contention, if the money be spent for one industry and not for another. This history of our educational system is replete with instances of wasted effort, time and money to introduce and maintain special schools of one kind or another in connection with the traditional subjects of an academic nature.

We do not have in our social structure such centralized power in municipal, State or national government that could order any or all communities to introduce and maintain schools for specific trades. Here and there laws have been passed permitting or compelling the establishment of manual-training or trade schools in cities of a given size. Here and there by the coincidence of public spirit, ample means and favorable industrial conditions, some school or schools for half a dozen trades may exist and even flourish. But there is the ever-changing will and degree of intelligence of the taxpayer to be reckoned with in an attempt to establish and maintain a system of trade schools. That is, such schools which claim to turn out mechanics able to take their places in the shops.

Uncertainty of Public Sentiment

Even granting that economic necessity

*Chairman, Committee on Industrial Education, American Foundrymen's Association.

will compel industrial communities to establish such schools, the very extent to which such a system would have to be carried on in order to satisfy the necessities of all industries, would militate against the possibility of maintaining such schools upon a satisfactory effective standard. And if a high standard could not be maintained the dissatisfaction arising therefrom with the school would be detrimental to its further usefulness.

In all our communities, the conservative, the "kicker," the disgruntled taxpayer and the tax dodger are always present and have a following. Circumstances in the social and political life of a city are constantly happening which bring these disgruntled taxpayers to the front and—presto! change—down goes your laboriously built up educational annex. This uncertain factor of popular will, this extra hazardous risk to be able to maintain special schools at a satisfactory standard of efficiency, if not backed up by governmental authority and compulsion, is a valid objection against trade schools as part of the organic whole of our educational system.

I am familiar with several cases of the kind and know of a case right now in an American industrial city, where the prosperity of the city depends upon the skill and intelligence of the workingmen, and where a fine manual-training school was built up slowly and carefully by the aid of a progressive school board and the substantial help of a leading industry. But a change in sentiment among the people brought in a reactionary school board and the fine manual-training organization was completely destroyed, and it will take years to regain the lost ground. Whenever, in the United States, an additional subject to our schools does not have a firm anchorage in the impelling force of sentiment with the taxpayer's mind and his material interest, it has a very precarious existence at best and waste of the taxpayer's money is the result.

But even if this precarious dependence of trade schools upon the will of the changing popular sentiment was no objection to the establishment of such a system of schools, there is the other objection of the inability of our educational system carrying on, at the same time successfully, the academic branches and industrial branches side by side. Before attempting to establish a system of special vocational education, there must be established and firmly maintained a system of elementary general education. This is fundamental. To lower the standard of general education for the sake of specific vocational training, is to defeat the object of vocational training which has for its aim a more intelligent and a more skilful industrial worker. Specific vocational or trade training is not effective and efficient to the degree it ought to be, for the time and money expended, unless the pupil enters the school well prepared in the fundamentals necessary for him to understand the higher branches of knowledge which must make him successful in his special schooling and calling.

Guarding Against Constructive Error

And here it is where the educational history of our country cautions us against committing a constructive error by trying to force upon the school the function of specific vocational training. The history of manual training, of kindergartens, of drawing, physical culture and nature study in our schools, teaches us that the traditions and conditions of the school and school room will eventually reduce the special subject to the scholastic terms of the general education of the school. Thus guided by the hand of the historic development of the American educational system, we can discern how, if we introduce specific trade training into the school as part of the school curriculum, such training will, in the course of time, be stripped of the substance which was to make its specific character valuable to our industries, and share the fate of other specific subjects with which the school was intrusted for their exclusive care.

To say this is no disparagement to our schools and teachers. They are earnestly and sincerely trying to find a solution for the problems which have been thrust upon the school by our phenomenally rapid material development. In their associations the teachers strive hard to meet manfully and conscientiously the growing complexities of the educational situation. But the conditions which govern our schools and their organization are stronger than the good will of the teachers and hence it has come about that they are forced by conditions to reduce special subjects to the scholastic terms of the school room and the requirements of general education.

Manual training was introduced into our schools with the idea of preserving for coming generations the Yankee ingenuity of the "Jack of all trades" era of our industrial history prior to 1870. Now manual training has done and is doing incalculable good for our country and it deserves our earnest and continued support. No one is more willing to acknowledge this than I am, for I have fought for manual training these 40 years. But manual training has become largely a subject for recreation in the school. More manual dexterity drilling is the main accomplishment now of that subject in our schools. As the educational representative of a national industry, I have tried to ascertain whether the manual-training people could or would save us the expense of a special system of schools devoted to industrial manual training. But no encouragement was held out by the authorities consulted upon the subject.

Power of School Tradition

The same tendency toward a retrogression from the original ideal of the kindergarten toward a mechanically conducted, pattern-shaped kindergarten, devoid of Froebel's underlying ideas, was a subject of discussion among teachers at a recent annual meeting of the Pennsylvania State Educational Association, and is another indication of the power of school tradition and school organization to force all subjects, designed to be connecting links between the internal life of the school and the external life of social activity, into a straight jacket of scholastic uniformity and the emphasizing of the technique of the subject at the expense of its substance and ideals.

Drawing, physical culture, nature study are similarly affected and are proof of the tendency and power of the school to adjust the subject to the requirements of its traditions and conditions. And judging from past and present there is nothing to warrant us in the belief that specific trade education would not meet the same fate. All the more would this be the case because trade education would require greater and continuous efforts to keep it in touch with the outside world.

To say that the mechanical work of a trade school has nothing to do with the academic work of the elementary public school is begging the question. The aim of industrial and specific trade education is greater skill and more of what the Massachusetts Industrial Commission aptly calls "industrial intelligence." Neither of these qualities can be attained without a solid foundation of humanistic and technical and civic subjects in better ordered quantities than those subjects are given in our schools now. This in itself will strain the school and if industrial education is added at 12 or 14 years of age, it is all the school can be expected to carry pedagogically as well as financially.

Some Vital Factors

Moreover, if specific trade education is attempted when the boy leaves school at 14, comparatively few can and will avail themselves of the opportunity because either they do not know what they want, or because they cannot afford to spend three or four years in a trade school without compensation and then still receive low wages when entering a shop because of lack of that practical experience which can be acquired only in the commercial shop. And after considerable money has been expended for specific trade schools to accommodate per-

haps a half a dozen trades, the school still has no provision for the great mass of those who either cannot have a trade school for lack of funds or because an industrial education is just as vaulable to them as a specific trade education will be.

To put the trade school in the same social relation toward the mass of industrial workers as the high school now occupies would be unwise and uneconomic from both the social and industrial standpoint. Nor should we leave out of consideration the question of a suitable and sufficient supply of teachers for the industrial and trade schools. The academically trained teacher cannot teach a trade. The practical mechanic without pedagogic training may be able to impart to the student the mechanical manipulations of his trade, but he cannot make the proper connection with the pedagogic end of his work, and therefore is out of joint and harmony with his surroundings and will be deficient to that extent. It is clear that this does not make the final results of the specific trade school more effective.

In the above argument against the desirability of burdening our schools with specific trade education, I have had in mind the large number of prospective industrial workers to be provided for with such a training if our industries are to be helped to any extent. Here and there successful attempts may be made under the influence of the spur of the moment, to introduce trade education into the public-school system. But these are only a drop in the bucket at best and are liable to be reduced to comparative uselessness at any time if public opinion should undergo a change.

We deceive ourselves if we leave these vital factors out of consideration. The instances of reaction of public sentiment and consequent crippling of the enterprise are too numerous in the history of our educational system to be ignored lightly and with impunity. Even economic necessity is no safeguard against the fickleness of popular opinion and will.

Moreover, educational waste ought to be avoided just the same as waste of material resources. And it would be educational waste to try to imitate shop conditions and shop practice in our public school upon a large scale, such as specific trade education requires if such schooling is to amount to anything. This waste would be all the greater because of lack of a sufficient number of pedagogically trained teachers.

Columbia University, with a creditable true insight into actual conditions, has begun to offer training classes for prospective industrial and trade-school teachers. But the additional financial burden being considerable if the specific trade schools, with all their necessary expensive equipment, should be freely established, school boards would be constantly tempted to reduce the salaries of the teachers to a minimum, and thus tend to keep the best men out and cripple the service.

Summary

Summing up the present aspect of the relation of the school to industrial and trade education, we find an antagonism existing between the fundamental, the humanistic or academic element of the school curriculum and the technical and mechanical elements which constitute the educational instrumentalities of a purely specific trade education.

This antagonism crops out under present conditions of our school organization whenever the fundamental humanistic elements and the industrial elements are brought together, side by side, under the same organization and management for the education of the masses. They are both weakened by the contact because of their apparent antagonistic nature and those elements which are least congenial in their nature to an association with the fundamentals, like in specific trade education, are reduced in efficiency by the contact; hence produce unsatisfactory results in the long run, resulting in pedagogic and economic waste. And, incidentally, industrial education does suffer less by this contact with the fundamental elements of the school because it is more in harmony with these elements than specific trade education is. If the plan for industrial education could be carried out as proposed in the *Educational Review* for December, by Dr. James E. Russell, dean of Teachers' College, Columbia University, both the fundamental and the industrial educational elements would be so harmoniously corelated, coördinated and supplement each other that the existing apparent antagonism would soon largely disappear.

We say apparent antagonism because in reality there is nothing in industrial and specific trade education which is of less intrinsic value as carriers, supporters and promoters of civilization and human progress than there is in humanistic studies. The apparent antagonism arises from the fact that the humanistic studies of the public schools, the three R's, are the exponents, the symbols of intellectual life, the indispensable instruments of civilization, while those studies which give the power of motor activity, of power of expression and creative and productive intelligence are considered to promote chiefly individualistic and purely egotistic activities, which are interpreted by many schoolmen as the handmaidens of commercialism and of those agencies which are destructive rather than promotive of the products of civilization and of ethical life; hence, antagonistic to the traditional symbols of civilization as expressed by humanistic studies in the public schools. Hence the belief with many that industrial education is devoid of cultural elements which in turn produces that unsympathetic attitude of mind of the school toward specific trade education, which is such an undesirable feature in the movement.

And since specific trade education is exclusively concerned with the teaching of the manipulations of a particular trade and only so much technical knowledge is taught as is necessary to interpret the meaning of these manipulations and does not concern itself with the man as a citizen at all, therefore specific trade education suffers unconsciously most from this apparent traditional antagonism and incompatibility between humanistic and trade education when brought together in the atmosphere of the public school and high school.

Less so is this the case between humanistic and industrial education while manual training has already yielded up entirely its original object of serving the industries; it has become part of the machinery of general education. This is the weak spot in our educational system when we trust the industrial economic education into its keeping without a suitable counter check and division of responsibility.

In all our discussion of the relation of the school to industrial and trade education we should not forget that the whole machinery of our school organization has been devised and perfected for generations solely for the purpose of bringing the humanities, the three R's, as representing civilization, face to face between the teacher and the child without consideration of the external conditions of vocational or commercial life. For that reason manual training, nature study, drawing, physical training, singing, domestic science have not been absorbed into the educational system as part of the organic whole, but are there only by sufferance to the extent to which they yield and adjust themselves to the traditional machinery of the school organization. The educational machinery being incapable of change, the study is changed. For that reason also those trade schools which stand alone are more or less successful, but suffer for lack of suitable preparation in the schools below and reach only an insignificant percentage of the great numbers to be educated.

The Cincinnati and Fitchburg Plans

What, then, can be done? We must find a plan for our industrial and trade education which yields all the school can give us and counterbalances the forces of the school machinery and, at the same time, strengthens the school.

The means to do this we find in the Cincinnati plan recently adopted, where the industries coöperate with the school.

By sending the apprentices to the school for a given period during the week, the school assumes the responsibility for the academic and technical part, being in a position to make full use of the machinery of its organization as far as the training of the teachers will permit this, while the purely external part of the studies, the manipulation of the mechanisms pertaining to a particular trade and the practical use of processes, is left to the shop. In other words, it is a natural and rational shop-trade education with the school furnishing what the shop cannot furnish. This same plan is applicable under various modifications for semi-skilled and unskilled industrial workers. The Cincinnati plan is preferable to the Fitchburg plan, inasmuch as the Cincinnati plan seems to be more flexible and economical when obliged to handle pupils from trades where there are but few apprentices and where it would not pay to have a shop instructor to follow up and round out the work of the school. The advantages of the Cincinnati plan are found in the relief of the school from that part of the work for which its machinery is not well adapted. It divides the responsibility between the school and the industries in proper proportion. Both are mutually stimulated to make the best use of their inherent powers and to strengthen each other.

The substance of the studies to be taught can be adjusted to the needs of the trade or trades and to the intellectual caliber of the pupils or their preparatory training. The school, respecting the instruction, being a continuation of the instruction of the schools below, opportunity is offered to ascertain the weak points in the previous preparatory training, thus perfecting the machinery of organization which necessarily reacts favorably upon the shop methods and shop economics. What the shop loses in time is amply regained by getting all the school can give economically without waste, both supporting and supplementing each other and advancing naturally along lines of least resistance, the shop forcing the school to improve the training of its teachers, the school forcing the shop to make use of all that is given by the school, or else lose its benefits.

An additional advantage of both the Fitchburg and Cincinnati plans is that they keep the business men and employers in constant touch with the school from an incentive to get the best out of it and thus is given an opportunity to study the schools' and teachers' needs and complexities, and become interested and aroused to keep reactionary and unworthy elements out of boards of education.

The weakness of the shop school lies in the break of the continuity of systematic mental effort by those who become apprentices at 16. Thus the shop school has to gather up the interrupted, loose, disorganized and unwilling ends of the threads of mental activity where the boy dropped them at 14 or earlier. This is at best a thankless task and the shop school loses valuable time to do elementary work. This weakness is not strengthened by the shop teacher having no pedagogic training. Two remedies are at our disposal to remedy this weakness. To send the shop teachers to Teachers' College, New York, for a year or two, to get a pedagogic education and to establish a standard efficiency of preparatory training for boys entering shops. The weakness of the school shop consists of being under the control of the machinery of an organization which was devised for another purpose and that it has to imitate shop conditions in the school room, for which it is not prepared and, being an imitation, the product of the specific trade-school shop partakes of the nature of a counterfeit.

By the above is not meant that we should not use a plentiful supply of shop tools in our coming industrial public school, but to use those tools for effective industrial educational purposes is one thing, and to try to weave around these tools an imaginary, at best artificial and fragmentary, commercial shop atmosphere, is another thing.

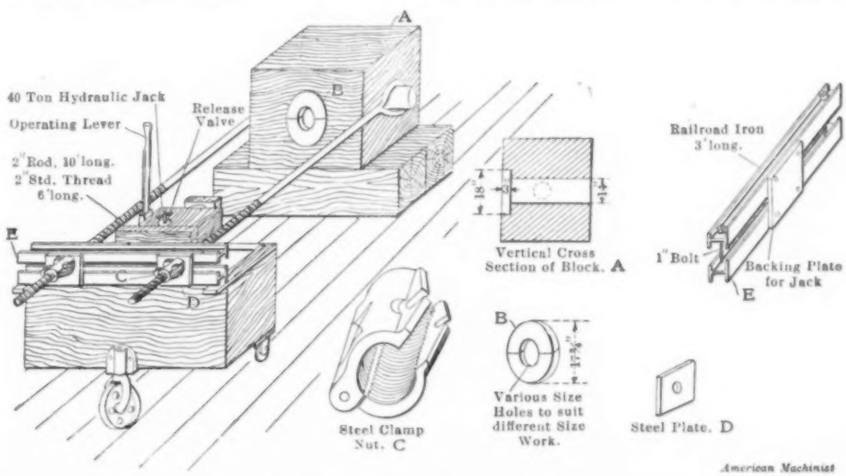
A Makeshift Wheel Press *By A. F. Orman*

For a long time after I accepted my present position, we had trouble every time we had to make a force fit on a shaft over 2 inches in diameter. Evidently my predecessor thought that a force fit and a sledge-hammer fit were the same thing. At first I was unable to convince my employer of the economy of a hydraulic press, but later he stretched a point and bought an old and decrepit hydraulic jack.

We finally got the jack repaired so that it would give us its maximum pressure. In the meantime we found an old casting with a lug on each side; had it bored large enough for our purpose; gave the blacksmith an order for two eye bolts; got out two pairs of cast-steel clamp nuts; made a backstop of railroad iron for the jack, and made split collars from stock we had on hand to reduce, when necessary, the size of the hole in the main casting. We set the machine up, as shown in the cut, and had a hydraulic press which is always ready at a moment's notice, and which really cost us very little.

It has nothing on it to break, therefore nothing to repair, and altogether is a very satisfactory machine. We don't have half the fits to make now that we had when we put them on with screws, because the fit is so much better that the machines run more than twice as long before needing repairs.

The work done on the machine is none the less satisfactory because of its makeshift character.



A Makeshift Wheel Press

Steel Pipe Couplings

Many thousand pipe couplings, both straight and reducing, are now being made of steel, from bar stock in automatic screw machines. The sizes do not often run over ¾ inch as yet but will probably go higher. They cost little if any more than the common kind and are strong and reliable enough to stand high pressure in oil pipe lines. In fact it was for this purpose that they were first made.

ENGINE DRIVING by COMPRESSED AIR

Air, Power and Coal Required Using Reheat, Cutoff and Expansion

BY SNOWDEN B. REDFIELD

Compressed air as a medium for driving reciprocating devices such as rock drills, pneumatic tools and even steam pumps is well established in the field of engineering. Under certain conditions compressed air is sometimes used for the driving of reciprocating engines with flywheels, valve gear and all the appurtenances of a regular steam unit. Most compressed-air installations, however, are anything but economical from a fuel standpoint and indeed in the case of rock drills and pneumatic tools the principal object is to get the work done with economy of labor rather than with economy of fuel.

In many cases it would be quite convenient to drive steam engines by compressed air and this is being done at the shafts of some of the Western mines, for operating hoists of large power. Up to the present time electricity has not been successfully applied in this country to hoists of great depth and in cases where the power is obtained from long distances by electric transmission it is very convenient to transform this electricity into compressed-air power for the driving of the hoisting engines. In these cases economy of power is much to be desired even if that power comes from a waterfall, for the more economically this power is used the greater percentage of the possible output of the plant, transmission wires, etc., representing a given amount of money invested, can be usefully employed.

Owing to these developments there have been at various times, inquiries as to the amount of air necessary to operate engines of given size, and the economy that can be obtained thereby or, in other words, the amount of fuel to be consumed to develop a given horsepower in the engines which are operated by the compressed air. Very few actual data from experiments are available on these subjects, but the figured results shown by the accompanying diagrams give much information which should be of value in this connection. These results have been figured not only for theoretical conditions, but also for what is more important; practical conditions as well. The curves plotted from these figures will then give the results which should be obtained with perfect apparatus and also with ordinary machinery in commercial use. The theoretical results will be found useful for studying the subject and for the checking up of actual results obtained from the machines themselves. The figures for practical performance are based upon actual conditions of operation such as would be obtained in any well organized plant, taking into consideration every probable defect in the mechanism and operation, which it would not be possible to avoid. Results obtained from these curves based upon what should actually occur in a real plant should be found especially valuable for estimating purposes, for the installation of new equipments.

The Proposition

It is proposed in the calculations from which the curves are plotted to drive a reciprocating steam engine having a flywheel and valve gear, the latter being capable of suitable adjustment to give the results desired. Compressed air is supposed to be furnished by an ordinary reciprocating compressor of modern design and ordinary performance, this compressor for the purposes of fuel calculation being supposed to operate by steam.

It is well appreciated that to obtain economy in an engine of any sort expansion of the gas operating in the cylinder is necessary. In other words, there must be cut-off in the engine cylinder. Expansion of compressed air, as is well known, when operating behind a working piston, leads to excessive drop in the temperature of the air. This drop in the temperature simply indicates that the energy in the air, which is, of course, the heat in the air, is being given up and transformed into work which is being delivered to the shaft of the engine. Expansion of compressed air in an engine cylinder is not greatly different from adiabatic expansion because there is very little chance for heat to be given to the air inside the cylinder by radiation inward from the cylinder walls. Consequently the temperature of the air at any point in the expansion curve can be calculated within a very few degrees by the ordinary adiabatic formula.

If expansion in the engine cylinder using air is carried to too great an extent the temperature of the air in the cylinder will fall below 32 degrees Fahrenheit and consequently the moisture in the air will freeze, this freezing leading to the clogging up of the exhaust ports of the engine, the formation of ice all over the outside parts of the cylinder and very probably the stopping of the engine altogether. For this reason it is essential in using compressed air in an engine cylinder to see to it that the temperature of the expanding air does not fall below the freezing point.

In all the calculations connected with this case it is assumed that the terminal temperature of the expanded air in the engine cylinder shall fall to 35 degrees Fahrenheit and no lower. Under this assumption the engine is supposed to be given an earlier and earlier cut-off to give greater and greater economy. Earlier cut-off will, of course, mean greater ratio of expansion and this in turn means a greater drop in temperature of the air. In order, therefore, to insure that the terminal temperature of the expanded air shall not be lower than 35 degrees, it is assumed that the air entering the engine cylinder is heated to a temperature such that with the given cut-off, the final temperature shall not be below this point.

The Theory First

To study the conditions imposed it will be well to look first at the theoretical side of the question. Glancing at the accompanying chart, in the upper left-hand portion will be found four indicator diagrams. The two upper ones are for strictly theoretical conditions, the left-hand diagram being that of the air cylinder of the compressor and the right-hand diagram that of the working cylinder of the engine being driven by the compressed air. The two indicator diagrams below this represent practical conditions, taking into account all the usual losses due to imperfect mechanical devices and faults in operation.

To make the theoretical case simpler it is assumed that the temperature of the atmosphere is 35 degrees Fahrenheit. The air at this temperature enters the cylinder of the compressor and in a single stage is compressed up to 90 pounds gage pressure, when as shown by the upper left-hand diagram its temperature will be 415 degrees. This air is then supposed to enter the engine cylinder without any loss of pressure or temperature. If now the valve gear of the engine is set to cut off at just about 0.26 the air in this cylinder will be expanded down to atmospheric pressure and its temperature will have been reduced to 35 degrees. At this temperature and atmospheric pressure it is assumed that the air is exhausted to the atmosphere.

Such an arrangement as this would mean ideal conditions and the efficiency calculated from the ratio of the work done in the engine cylinder to that done in the air-compressing cylinder will be

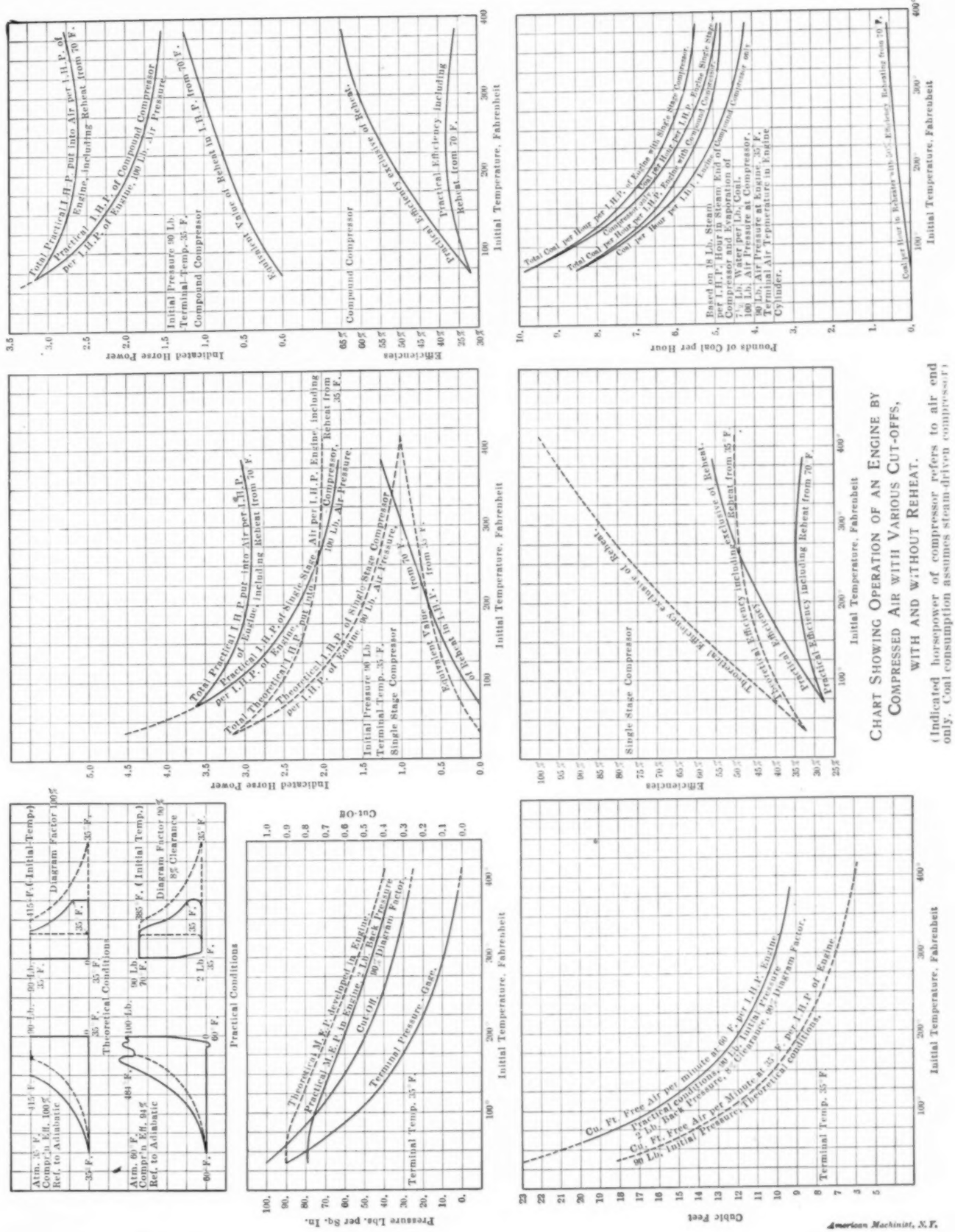

Total Practical I.H.P. put into Air per I.H.P. of Engine, including Reheat (from 70° F.
Practical I.H.P. of Compound Compressor per I.H.P. of Engine, 100 Lb. Air Pressure
Saving of Reheat in I.H.P. (from 70° F.
Initial Pressure 90 Lb.
Terminal Temp. 35° F.
Compound Compressor
Indicated Horse Power
Initial Temperature, Fahrenheit
Compound Compressor
Theoretical Efficiency excluding Saving of Reheat.
Practical Efficiency including Reheat from 70° F.
Efficiencies
Total Coal per Hour per I.H.P. of Engine with Single Stage Compressor.
Total Coal per Hour per I.H.P. Engine with Compound Compressor.
Coal per Hour per I.H.P. Engine
Based on 18 Lb. Steam per I.H.P. Hour in Steam End of Compressor and Evaporation of 7½ Lb. Water per Lb. Coal.
100 Lb. Air Pressure at Compressor.
90 Lb. Air Pressure at Engine. 35° F. Terminal Air Temperature in Engine Cylinder.
Coal per Hour to Reheat with 50% Efficiency, Reheating from 70° F.
Pounds of Coal per Hour
Total Practical I.H.P. put into Air per I.H.P. of Engine, including Reheat from 70° F.
Practical I.H.P. of Single Stage Compressor per I.H.P. of Engine, 100 Lb. Air Pressure.
Total Theoretical I.H.P. put into Air per I.H.P. of Engine, including Reheat from 70° F.
Theoretical I.H.P. of Single Stage Compressor per I.H.P. of Engine, 90 Lb. Air Pressure.
Saving of Reheat in I.H.P. (from 70° F. Value of Reheat in I.H.P. (from 35° F.
Initial Pressure 90 Lb.
Terminal Temp. 35° F.
Single Stage Compressor
Theoretical Efficiency excluding Saving of Reheat.
Practical Efficiency including Reheat from 70° F.
Theoretical Efficiency including exclusive of Reheat from 35° F.
Theoretical Efficiency excluding exclusive of Reheat.
Cu. Ft. Free Air per minute at 60° F. per I.H.P. Engine.
Practical conditions, 90 Lb. Initial Pressure
2 Lb. Back Pressure, 8% Clearance, 90% Diagram Factor.
Cu. Ft. Free Air per Minute at 35° F. per I.H.P. of Engine.
90 Lb. Initial Pressure, Theoretical conditions.
Terminal Temp. 35° F.
Cubic Feet
Initial Temperature, Fahrenheit
Theoretical M.E.P. developed in Engine.
Practical M.E.P. in Engine, 2 Lb. Back Pressure
Cut-Off. 90% Diagram Factor.
Terminal Pressure—Gage.
Terminal Temp. 35° F.
Cut-Off
Pressure Lbs. per Sq. In.
Initial Temperature, Fahrenheit
Atm. 35° F. 415° F.
Compr'n Eff. 100%
Ref. to Adiabatic
35° F.
90 Lb. 35° F.
Diagram Factor 100%
415° F. (Initial Temp.)
35° F.
Theoretical Conditions
Atm. 60° F. 484° F.
Compr'n Eff. 94%
Ref. to Adiabatic
60° F.
100 Lb. 90 Lb. 70° F.
385° F. (Initial Temp.)
Diagram Factor 90%
85% Clearance
35° F.
2 Lb. 35° F.
Practical Conditions

Chart Showing Operation of an Engine by Compressed Air with Various Cut-offs, with and without Reheat.

(Indicated horsepower of compressor refers to air end only. Coal consumption assumes steam driven compressor.)

American Machinist, N. Y.

100 per cent. Furthermore, the mean effective pressure theoretically developed in the engine cylinder would be about 39 pounds and the indicated horsepower developed in the air-compressing cylinder per indicated horsepower developed in the cylinder of the engine using the compressed air would, of course, be 1.

This is the extreme and only theoretically possible case. The worst possible case that we could have under theoretical conditions would be to assume that after the air has been discharged from the compressing cylinder at 415 degrees and 90 pounds pressure it should have become entirely cooled down while passing through the air pipe leading from the compressor to the engine, so that its temperature when reaching the latter is only 35 degrees. The pressure is assumed to remain at 90 pounds. Under these circumstances it is, of course, impossible to allow any expansion of the air at all because no drop in temperature is allowable or freezing will take place. The engine must then admit air through the full stroke, when the exhaust valve would open and the air would expand simply into the atmosphere without doing any useful work and without any appreciable temperature drop.

Under these circumstances the indicator diagram would be represented by a rectangle, there being no slanting expansion curve. This would, of course, give very poor economy because although theoretically 90 pounds mean effective pressure is developed in the engine cylinder, there being no expansion a very large volume of air must be used, comparatively speaking, in order to do a given amount of work. To develop 1 indicated horsepower in the engine cylinder under such conditions, without expansion, it will be found that the compressor will be called upon to develop about 3.2 horsepower in its air-compressing cylinder, giving a theoretical efficiency of only about 32 per cent.

Between these two cases of the theoretically perfect, that is, admitting air at 415 degrees directly from the compressor, expanding down to atmosphere and 35 degrees, and the case where the air is admitted to the engine cylinder at 35 degrees and no expansion at all is allowed, there is a wide range of possible conditions. In the calculations, therefore, it is assumed that the air coming from the compressor is admitted to the engine cylinder at various temperatures ranging all the way from 35 degrees as a minimum, to 415 degrees as a maximum and in each case the cutoff is so set that the air in the engine cylinder will expand down until at the end of the stroke, its temperature has dropped to 35 degrees. Such an intermediate indicator diagram is shown by the full lines in the upper left-hand section of the accompanying chart. Such conditions will, of course, give rise to an economy which is intermediate between that of the perfect theoretical conditions and the most imperfect theoretical conditions, as described.

Cutoff, Mean Effective and Terminal Pressures

To follow through the results which would be obtained with various initial temperatures of the air entering the engine cylinder it will be necessary to examine the various diagrams on the chart. Looking first at the middle diagram on the left-hand side of the chart, we will see that when the air enters the engine cylinder with an initial temperature of only 35 degrees, the cutoff, as shown by the line so marked, will be unity, that is, there will be no cutoff at all. This, as shown, will result in a mean effective pressure in the engine cylinder of 90 pounds, there being no loss assumed under these theoretical conditions. There being no expansion the terminal pressure will also be 90 pounds as shown by the curve marked "Terminal Pressure."

Following these curves a little further we will find that if the air is admitted to the engine cylinder at 100 degrees Fahrenheit it will be possible to so set the engine valves that the cutoff may occur at about 0.75 of the stroke. This will result in a theoretical mean effective pressure developed in the engine cylinder of 85 pounds and the terminal pressure by the time the temperature has dropped to 35 degrees will be found to be 53 pounds. At 300 degrees, under these theoretical conditions the cutoff may be set at 0.35 stroke. The theoretical mean effective pressure developed in the engine cylinder will then be about 53 pounds and the terminal pressure will have fallen to about 9 pounds, the terminal temperature, of course, being 35 degrees as in every case. If the air is allowed to enter the engine cylinder at 415 degrees, the results will be as already outlined for the most perfect theoretical conditions.

Quantity of Air Required

After this study of the engine indicator diagram we may determine the quantity of free air required per minute to develop 1 indicated horsepower in the engine cylinder, under these same varying conditions. Looking first at the theoretical state of affairs as shown by the dotted curve in the lower left-hand section of the chart we will find that with 35 degrees initial temperature in the engine cylinder it will require a little over 18 cubic feet of free air per minute to develop 1 indicated horsepower. At 300 degrees initial temperature about 7 cubic feet of free air and at 415 degrees about 5.9 cubic feet, will be required per minute to develop 1 indicated horsepower in the engine cylinder. In each case this air is measured at atmospheric pressure and 35 degrees temperature.

Reheating

At this point something should be said about reheating, as this is one of the most important points in the use of air in engines having cutoff. So far we have assumed that the air delivered to the engine has simply cooled off to a certain point as it passes through the pipe line between the compressor and the engine. Under actual conditions it usually happens that the air has cooled down to very nearly atmospheric temperature before reaching the engine and consequently in order to obtain economy by the use of cutoff in the engine it is necessary to reheat the air in some suitable device known as a reheater, before allowing it to pass into the engine cylinder. This reheating of the air, of course, means the consumption of additional fuel but owing to the nature of compressed air itself, this additional heat put into the air will develop power in the engine cylinder with an economy practically unattainable by any other method of transforming heat energy into motion. By means of separate reheaters, therefore, it is possible not only to use compressed air in an engine where conditions make it imperative to use air instead of steam, but it is also possible to develop power with a very reasonable degree of economy from the coal pile.

When burning coal under a steam boiler an economy of 70 or 75 per cent. is possible and often attained. With a properly designed reheater for heating the compressed air before entering the engine it is undoubtedly possible to obtain an economy equal to this but under ordinary working conditions the reheater in an air plant receives but scant attention unless a special man is hired for this purpose. Indeed, considering the neglect which reheaters receive under usual conditions the economy obtained by their use is wonderful. However, not to favor the reheater too much it is assumed in these calculations that the efficiency of the transference of the heat from the coal to the air is only 50 per cent. In other words, only one-half of the heat available in the coal is assumed to have been put into the compressed air in the reheater before actually entering the inside of the engine cylinder.

This compares with rather poor steam-boiler practice but at this point the analogy ceases for with the steam plant although the steam may contain 70 or 75 per cent. of the heat of the coal, only about 12 or 15 per cent. of this heat is actually transformed into work in the engine cylinder. On the contrary, when using heated air in an engine cylinder the economy of the transformation of the heat in the air into work may well reach 80 per cent.

Power in the Reheater

All heat which is put into the air in the reheater must, of course, represent

additional energy from the coal pile just the same as the energy which is put into the air by its compression in the air compressor and therefore the coal burned in the reheater should be charged against the plant in obtaining the total economy. In the upper central diagram and also in the upper right-hand diagram showing power curves will be found curves marked "equivalent value of reheat in indicated horsepower." The dotted curve, representing the theoretical conditions, assumes that the air is reheated from the temperature of the atmosphere, namely 35 degrees Fahrenheit, to the various initial temperatures marked underneath the curves. Practical conditions will be described further on.

Examining the upper central diagram it will be found that for the theoretical conditions as shown by the dotted line the equivalent value of the reheat is, of course, zero, when the air enters the engine cylinder at 35 degrees and when the initial temperature is raised to 100 degrees it is seen that the heat in the air is equivalent to about 0.37 indicated horsepower per indicated horsepower developed in the engine cylinder by the hot compressed air.

This increases as the temperature is raised until finally, when the air is reheated to an initial temperature of 415 degrees, corresponding to the temperature at which it left the compressor cylinder, the heat put into the air is equivalent to 1 indicated horsepower per indicated horsepower developed in the engine cylinder.

We have already found that in order to compress the air up to 90 pounds pressure and develop 1 indicated horsepower in the engine cylinder under the theoretically perfect conditions, 1 indicated horsepower has also been developed in the compressing cylinder. This goes to show, therefore, that all of the work which is done in the engine cylinder has come from the heat in the air and as it has been assumed that the compressed air has entirely cooled down to 35 degrees and then been reheated by the separately fired reheater to 415 degrees, it is this extra heat put into the air in the reheater which does the work in the engine cylinder. As far as the work done in the compressor is concerned this latter is all thrown away when the air in the pipe line has been allowed to cool down to its original atmospheric temperature. In other words, under these circumstances, the compressor has done 1 indicated horsepower of work, which has then been lost in radiation and the reheater has added another indicated horsepower in the shape of heat, making 2 indicated horsepower expended upon the air to develop 1 indicated horsepower in the engine cylinder. This is a theoretical efficiency of 50 per cent.

Efficiencies

All of these factors of horsepower developed in the compressor; horsepower put into the air in the reheater, and total indicated horsepower put into the air per indicated horsepower in the engine, will be found in the upper central diagram. In the lower central diagram will be found the corresponding curves for efficiency. Two of these curves are marked "efficiency exclusive of reheat." By this is meant that no reheater is used, but that under the conditions of operation the air from the compressor has simply cooled down by radiation in the discharge pipe, from its natural temperature of 415 degrees, to the various initial temperatures shown at the bottom of the diagram and that the work done has actually come from the compressor only. This work of the compressor is represented by the line in the diagram just above, marked "indicated horsepower of single stage compressor per indicated horsepower of engine," etc. The indicated horsepower of the compressor refers to the air end only, in all cases.

Practical Conditions

So much for theoretical conditions. Theoretical conditions are all right to study the situation and determine the method of calculation, but practical results are what are desired. Looking now at the two indicator diagrams marked "Practical Conditions" in the upper left-hand corner of the chart, it will be found that the following practical considerations are assumed: The atmosphere is assumed to be 60 degrees Fahrenheit, and the compression efficiency of the air cylinder of the compressor is assumed to be 94 per cent., that is, 6 per cent. loss over and above theoretical adiabatic conditions; 88 per cent. mechanical efficiency of the compressor is also allowed. Further, it is assumed that there is a ten-pound pressure drop in the pipe line from the compressor to the engine and consequently the compressor must pump the air to 100 pounds pressure, in order to reach the engine at 90 pounds. Also it is assumed that under the worst case of cooling of the air from the compressor, the initial temperature of the air in the engine cylinder is 70 degrees, or 10 degrees above the atmosphere. It is from this temperature that all the reheating is calculated under the practical conditions. Furthermore, the back pressure or exhaust of the engine using the compressed air, is considered to be 2 pounds above the atmosphere.

To allow for the rounding of the corners of the diagram, due to the operation of the valve gear, a diagram factor of 90 per cent. is used; or the mean effective pressure actually developed in the engine will be 90 per cent. of what would theoretically be obtained under the conditions of initial pressure and the given cutoff. As a final practical condition, the engine cylinder is supposed to contain 8 per cent. clearance, this clearance operating to increase the amount of air required. Just as in the theoretical condition, it is likewise assumed that the final temperature of the air after expansion is 35 degrees Fahrenheit, or just above freezing. No leakage in the system is taken into account, as it is considered that the pipe lines and connections for a permanent installation would have no more leaks than a similar steam pipe line leading from a boiler to an engine.

Practical Temperature Range

Under the best practical conditions allowing the air in the engine cylinder to expand down to two pounds above atmosphere for the back pressure, the initial temperature in the cylinder can be 385 degrees Fahrenheit. With these conditions a cutoff of about 0.27 can be used, resulting in a practical mean effective pressure in the engine cylinder, with all the above enumerated losses taken into account, of about 37 pounds. These conditions are shown by the dotted indicator diagram in the lower set, having these temperatures and pressures marked upon it, in the upper left-hand portion of the chart.

From the chart it will be seen that 385 degrees Fahrenheit is the maximum temperature of reheating which is practically considered. Of course, it would be perfectly possible to heat this air to a much higher temperature provided lubrication troubles were not encountered, but under these circumstances one of two things would happen. First, if the temperature were greater than 385 degrees, and the expansion were carried out to 35 degrees, the terminal pressure of the air in the cylinder would be below the back pressure; producing a loop in the indicator diagram. If, however, with an initial temperature greater than 385 degrees Fahrenheit, the expansion were carried down just to meet the back pressure line without producing either a drop or a loop, the temperature of the air in the cylinder at that point would be considerably above 35 degrees, and consequently we would not have obtained from the air all of the work available in the heat. This, therefore, would result in loss of economy. For these reasons the calculations have been stopped, as shown, with an initial temperature of 385 degrees Fahrenheit as a maximum.

Glancing at the full line curves in the lower left-hand diagram of the chart, this curve being marked "cubic feet free air per minute at 60 degrees Fahrenheit per indicated horsepower engine, practical conditions, etc.," it will be found that with a minimum initial temperature of 70 degrees Fahrenheit, about 20 cubic feet of free air per minute per indicated horsepower developed in the engine will be required. This falls off as shown by the curve until, with the most

advantageous practical conditions of 385 deg. initial temperature, about 9.3 cubic feet of free air will be required per minute per indicated horsepower of the engine.

Power Required

In the upper central diagram will be found the full line curves of practical conditions, showing the horsepower developed in the compressor, that added in the reheater and the total horsepower put into the air per indicated horsepower developed in the engine cylinder. In the lower central diagram will be found also the full line curves of practical efficiency.

All of the curves so far considered assume the use of a single-stage compressor. Glancing at the upper right-hand set of curves on the chart, there will be found results of practical considerations only and this time assuming the use of a compound compressor. All of the losses, as already outlined for the practical case, are included.

Maximum Power Economy

From the two curves of practical efficiency, including reheat from 70 degrees, this efficiency being from indicated horsepower in the engine cylinder to the indicated horsepower in the compressing cylinder of the compressor, it will be noted that a point of maximum efficiency is reached and so it would appear that there would be no advantage in reheating the air beyond 275 degrees when using a single stage compressor, or 250 degrees with a compound compressor. The curves show a decrease in efficiency after these temperatures are exceeded. As far as efficiency is concerned, this is true, but this is not the whole story. The efficiency in these particular cases does not mean dollars and cents directly, for, as already pointed out, the heat put into the air in the reheaters is developed into work in the engine cylinder at an extremely economical rate.

In order to understand this, it is necessary to glance at the lower right-hand set of curves as shown in the chart. Here the calculations are referred back to the coal pile, and all the results are strictly practical, the conditions imposed being as shown on this diagram. These conditions assume 18 pounds of steam per indicated horsepower per hour in the steam end of the compressor and an evaporation of 7½ pounds of water per pound of coal in the boiler, in addition to all the other practical conditions as to compression, expansion, pressures, temperatures and clearance already enumerated.

Coal Pile Economy

In this set of curves it will be found that there is one marked, "coal per hour per indicated horsepower of the engine, single-stage compressor only," and another one marked, "coal per hour per indicated horsepower of the engine, compound compressor only." These curves, as may be assumed from their marking, do not include the coal put into the reheaters, and may, therefore, be taken as the results, assuming that the air from the compressor has simply cooled down in its passage from the compressor to the engine, to the various initial temperatures as marked at the bottom of the curve. At the extreme bottom of the diagram will be found another curve which is marked, "coal per hour in the reheater with 50 per cent. efficiency, reheating from 70 degrees Fahrenheit." As intimated, this curve assumes that only one-half of the heat available in the coal burned in the reheater is actually present in the air after passing to the engine.

All the results in these curves are per indicated horsepower developed in the engine, and it will be found that with 385 degrees initial temperature, the compound compressor will require about 4.2 pounds of coal per hour, and the single-stage compressor will require about 4.9 pounds of coal per hour. However, glancing at the curve for the reheater, it will be found that at 385 degrees Fahrenheit only a little over one-half pound of coal per hour is required to heat the air to this temperature. The quantity of coal required in the reheater as given by the lower curve, is added to each of the upper curves marked, for the "compressor only," so as to give the total coal per hour per indicated horsepower of the engine, both with a single-stage and a compound compressor, as shown. This total quantity, it will be seen varies from 9.8 pounds per hour with no reheat and a single-stage compressor, to 5.4 pounds with reheating to 385 degrees. For the compound compressor this total coal per hour varies from 8½ pounds to 4.8 pounds per hour per indicated horsepower of the engine, according as the reheat increases and the cutoff shortens, giving greater economy.

It will be noticed from these latter curves that a point of minimum coal used is not quite reached as far as the calculations are carried out. It has already been explained why a higher temperature of reheating has not been figured upon. This then shows that reheating is economical from the dollars and cents point of view, even beyond the point where economy seems to decrease from the strictly B.t.u. point of view. This is due simply to the fact, as already explained, that the B.t.u. put into the air in the reheater are put in at a much cheaper rate than those put into the compressor through the steam cylinders of the latter. As a matter of fact, the trend of the curve for total coal per hour in the compound compressor, including reheat, does appear to reach just about a minimum point between 385 and 400 degrees Fahrenheit. This point, therefore, would seem to be the maximum reheat temperature for practical conditions. In fact with initial temperatures greater than this, trouble will be found to come from the carbonizing of the lubricant, so this again puts a practical limit at this point.

Making an Accurate Dividing Ring

By E. R. Connors

In making a jig for milling index rings for turrets the main point of construction was to get a master ring hardened and ground accurately so it would duplicate itself on the work being milled. The ring was about 17 inches diameter and the turret rings to be milled were about 10 inches.

How It Was Made

We had a ring made of tool steel by the smith and then turned it to grinding size. We then milled out the notches on a Brown & Sharpe dividing head on a miller; this being done we had it tempered. It was then placed on a Brown & Sharpe universal grinder, the faceplate having four pieces of 1½x½ cold-rolled clamped on it so as to extend the diameter necessary to clamp the ring on. We swiveled the head at right angles to the table so it would swing and then ground it inside and out with the internal grinding attachment; both faces were also ground. Then a disk was turned to fit and driven into the ring; it was then placed on an arbor on a Brown & Sharpe No. 5 gear cutter.

The cutter arbor was removed and a cast-iron block was shaped out to fit where the arbor support is. On this we mounted a small Hisey & Wolf electrical center grinder. We placed a 6-inch disk wheel on the arbor and set the machine to index the required number of notches. We set the feed for about 10 inches per minute and ground one side, then the other.

This showed that the tempering threw the spacing out about 0.012 inch from being equally divided. The grinding corrected this and gave us an accurate division master to be placed in our milling jig.

I have made index plates for dividing heads in the same manner, only I used an electric drill in place of the center grinder.

Use of Compounds in the Hardening of Steel

By C. U. Scott

I recently had a very interesting experience with a compound for heat treating steel. In fact, it is the compound of compounds, it having cost the possessor $75,000 for its secrets, and it cost him considerable more to find out that he had something that was worthless to himself, as well as others.

The fellow who sold the great secret(?) was supposed to be a real tool hardener, and he may be at his vocation yet, but I hardly think so, as he should have sufficient to live comfortably on without being bothered with any of the troubles connected with the hardening of tools and treatment of steel. The way he laid it over on the old gent was interesting. Just how they happened to meet I do not know, but it is not difficult to see how the job was done.

The buyer was just like some of the compound writers: He knew that some people had good results with their steel, while others made a miserable failure out of the most simple piece of work; not entirely because they did not have the appliances, but from the fact that they would not take the time to find out just what effect the heating and cooling had on the steel they were treating. He was looking for something from the hidden mysteries and he got it.

I would inform the reader of the ingredients used, but as I had to gather it from the labels that were thrown in the waste basket, I hardly think that I have the right to do it, admitting that I have it correct.

How the Game Worked

How the buyer became separated from $75,000 is about as follows: He was a firm believer in mysteries, and the hardener was quick to discover that the heat treatment could be applied in one heat, as he followed a method that would indicate that he knew what he was doing. He would select a bar of mild steel of not less than 1 inch in diameter, heat it to 1650 degrees Fahrenheit, then quench in the wonderful compound and let it cool down to 925 degrees Fahrenheit; then take it from the compound and let it cool, or allow the heat to pass out and draw the outside sufficient to permit of its being machined. Thus the martensite that was formed in the quenching is entirely broken up and the carbide is well distributed.

It is surprising to others, as well as the buyer, to see what enormous strength the steel has acquired by this simple heating and then sudden cooling down to a point where there is just enough heat to permit the breaking up of all hardness. While, of course, this is one of the most reckless methods by which heat treatment can be applied, yet it was the only one that the hardener could dupe the old gentleman with, and it could be applied without arousing any suspicion other than the fear that someone would enter and discover their secret(?) before they could protect it with a patent. However, they were allowed to get the patent and have it today.

Of course, if he were to call at your shop and ask to be permitted to demonstrate the powers of his compound you would not permit it. But when he had shown you the letters that have been given him by some of our prominent college professors, as well as some of the leaders of our polytechnic schools, presidents of railroads, etc., then possibly you would begin to scratch your cranium and do as others have done, that is, invite him to come in tomorrow and you would see if you could not arrange to give him and his wonder-worker a trial. If you did, and you knew what was taking place when he was applying his seven wonders, you might be able to discover a slight trace of the heat treatment. As it is not easily detected by anyone not entirely familiar with the methods employed in the treatment of steel, I hardly think they would discover what was going on as it is entirely hidden, except to the man who is handing out the lemon.

It is true that the treatment is simple, but when it comes to applying it intelligently and gathering the desired results, which is its full strength for what it is intended to do, it requires judgment in heats as well as in cooling and cooling baths.

Results of Proper Quenching

In some tests which we conducted with this compound on carbon steel, we were able to beat it, by quenching in oil or brine, from 13,500 to 41,300 pounds in tensile strength and from 12,000 to 30,450 pounds in elastic limit. On steel castings the compound was beaten as much as 55,630 pounds in tensile strength and 44,370 pounds in elastic limit. The following tables give the results of these tests:

Bar Number.	Tensile Strength.	Elastic Limit.	Elongation in 2 Inches.	Reduction in Area.
1	115,900	95,800	19.7	48.3
2	131,700	112,900	11.7	40.9
3	171,500	142,450	21.0	58.0

These tests were made with a 0.60 per cent. carbon steel and bar number 1 shows the results obtained from the untreated bar, while bar number 2 was heated and quenched in the compound as described above, and bar number 3 was heated to 1475 degrees Fahrenheit and annealed; then heated to 1500 degrees and quenched in oil, and then drawn at 1100 degrees.

The only specification in heat-treating 2 and 3 was that the elongation must not be less than 20 per cent.

The next test was made on a 0.30 per cent. carbon steel and resulted as follows:

Bar Number.	Tensile Strength.	Elastic Limit.	Elongation in 2 Inches.	Reduction in Area.
4	96,825	82,060	20.0	46.4
5	119,400	85,200	18.5	45.0
6	160,700	110,350	19.5	45.0

In this table number 4 is the untreated bar; number 5 was treated in the compound, as above, and number 6 was annealed from 1475 degrees, then heated to 1560 degrees and quenched in oil, and then drawn for 15 minutes in oil at 1050 degrees Fahrenheit.

The third test was made with low carbon steel with the following results:

Bar Number.	Tensile Strength.	Elastic Limit.	Elongation in 2 Inches.	Reduction of Area.
7	85,100	65,150	29.0	60.8
8	82,150	63,000	30.0	64.0
9	98,520	79,932	27.8	61.7
10	101,000	89,800	25.0	54.6

Here numbers 7 and 8 were treated in the composition as above; while number 9 was annealed from 1475 degrees, then heated to 1635 degrees and quenched in oil, and then drawn for 20 minutes in oil at 1040 degrees Fahrenheit. Number 10 was treated in the same manner as number 9 except that it was quenched in brine instead of oil.

The fourth test was on machinery steel and resulted as follows:

Bar Number.	Tensile Strength.	Elastic Limit.	Elongation in 2 Inches.	Reduction of Area.
11	71,000	48,500	33.5	59.0
12	79,350	51,700	27.5	59.0
13	71,830	47,565	33.5	61.6
14	87,800	62,784	29.5	58.0
15	86,850	61,900	27.0	57.3
16	88,100	59,975	28.5	59.1

This test was conducted to show the comparative results of quenching with the compound and with brine. All the specimens were heated to 1560 degrees Fahrenheit and quenched; numbers 11, 12

and 13 were quenched in the compound and numbers 14, 15 and 16 in brine.

The fifth test was made with pieces cut from the same part of the center of a steel casting in order to have them as uniform as possible, and resulted as follows:

Bar Number.	Tensile Strength.	Elastic Limit.	Elongation in 2 Inches.	Reduction in Area.
17	67,090	57,290	3.0	10.6
18	83,120	75,560	1.0	3.0
19	121,675	.....	...	0.2
20	120,745	87,335	3.0	7.1
21	138,750	119,930	2.5	5.1

Number 17 was the untreated bar as it was cut from the casting and numbers 18 and 19 were heated to 1500 degrees Fahrenheit and quenched in the compound. Bar number 20 was annealed at 1475 degrees; then heated to 1650 degrees for quenching, and drawn at 975 degrees Fahrenheit. Bar 21 was annealed at 1475 degrees; then heated to 1560 degrees and quenched in oil, and then drawn for 20 minutes in oil at 1025 degrees Fahrenheit.

Test number 6 was made from 0.25 per cent. carbon steel with the following results:

Bar Number.	Tensile Strength.	Elastic Limit.	Elongation in 2 Inches.	Reduction of Area.
22	94,750	72,375	23.0	36.0
23	123,025	80,185	14.0	38.0
24	92,050	54,100	28.5	39.0
25	137,050	94,000	15.0	35.0
26	162,000	130,500	13.5	24.4

These pieces were cut from a 3-inch bar and made a uniform size. Bar 22 was untreated and bars 23 and 24 were quenched in the composition at different temperatures. Bar 25 was annealed at 1475 degrees, then heated to 1560 degrees and quenched in oil, and then drawn for 20 minutes in oil at 1025 degrees Fahrenheit. Bar 26 was treated the same as number 25 except that it was quenched in brine instead of oil.

All of the effects of compounds can be explained where an improvement has been noted. For instance when quenching tools in potash, they begin to cool faster than they would if quenched in oil. By quenching in potash for a period of 15 seconds they cool to a point where it would not be necessary to further cool in oil, if it were not to prevent the tool from being drawn by the remaining heat. The more drastic the cooling the greater the degree of hardness obtained, but the best tool is not necessarily the hardest tool especially in high-speed steel.

The object in making this steel is to have a steel that will not anneal or become soft when it is worked sufficiently to cause it to heat say to a red heat. High-speed steel will be considerably harder if quenched from 1850 degrees Fahrenheit than if heated to 2400 degrees but it will require 750 degrees Fahrenheit more heat to break down this tool than the tool that had the low heat.

Some Facts Worth Knowing

Here are some facts that ought to make this subject plain to anyone. Let us suppose that we wanted to anneal some tools made of high-speed steel. Let us say there were three lots, the first of which was heated to 1800 degrees Fahrenheit, the second to 2000 degrees and the third to 2350 degrees, no matter how they were cooled (except in potash, then the outside must be ground off).

The first lot can be thoroughly annealed by heating to 1400 degrees Fahrenheit or they can be filed very nicely if drawn to a dark straw (this heat if used would cause the tool to fail).

The second lot can be annealed by heating to 1400 degrees Fahrenheit and allowed to cool slowly or if drawn to a purple it can be filed with ease. I mean by filing to work to shape.

The third lot will require different treatment as it has become non-annealable as far as any ordinary heat is concerned. It must be treated in order to anneal and it must be kept hot for some time in order to bring it back to its original condition. It can be heated to a blue or a red and not permit of filing but if heated to a red, allowed to cool and then heated again, as is the case with some tools, it will become soft. If held at a red heat for 35 minutes it will also soften. This is due to one of the natural laws of steels containing tungsten.

I wish I might be able to say something that would cause some of the users of compounds to do a little experimenting with at least 10 inches of say ¼-inch, round, high-speed steel. I would then think I had accomplished something that might do them some good.

Importance of Heat Treatment

Why is heat treatment of such great value to medium steel? That is steel ranging from 0.20 to 0.30 per cent. carbon. We are usually so busy that we do not have time to give this steel any consideration in the forging heat. Neither can we treat it as it should be treated as long as we use such crude methods for heating as we do. I know that some will say "our furnaces are all that can be desired" but I have failed to see any fire for forging that the steel cannot be over heated in, and I have failed to see any great amount of forging that is not done at a heat that is almost destructive rather than a help. I say this from experience and observation and see no hope of it being remedied, at present, unless it is done by heat treatment.

To heat treat steel, it must be annealed. This improves the metal in forgings. The next operation is heating after they are machined or nearly ready to assemble. Here it is possible to take a careful heat from the fact that there are no dies to be considered and all the energies can be centered on the heat rather than the possibility of making the piece in two strokes of the drop or with one heat. We cannot buy steel of any grade and then forge it at any heat that will allow the drop-hammer man to get out a day's work, if we want the greatest strength, toughness or wearing qualities in the metal. When the piece has been heated to 1560 degrees Fahrenheit and quenched in oil it is again improved in its physical qualities and is better than it was before it was heated and quenched. Now we have just one more operation in which to make the steel perfect and that consists of the letting down or drawing back. Here we cannot intelligently say what heat to use unless we know what the piece is to be used for.

Some Laws Explained

Steel obeys its natural laws when heated as well as when cooled, and if we want something different we must overpower one with the other and do it in such a manner that it will not destroy the tool or die. When steel is heated it becomes longer and when cooled it must therefore become shorter. As the heat is applied the grain opens up and the higher the heat the greater the expansion up to 1800 degrees Fahrenheit. There is some increase after this but very little. If this piece is quenched suddenly it returns to its original measurement and if not properly heated it will be shorter. If the piece is small, however, it will be longer than the original measurement.

As far as the heating is concerned we will leave it without further explanation. But the reason the steel gets shorter than its original measurement during the hardening process is that it cannot be cooled rapidly enough. If the piece is large and is cooled too rapidly it will set up strains between the hardened and unhardened portions and result in its destruction. This is caused by the outside cooling and shortening before the inside has had a chance to cool and shorten. The strains thus caused by this shrinkage force make the piece break. The more rapid the cooling the greater and more sudden will be the strains.

This can be overcome by using a very slow heat, one requiring three hours to bring the piece to the hardening heat, and then cooling slowly. There are but few tools that cannot be hardened to a good working depth by taking three minutes for the cooling. Therefore it is good practice to allow the piece to cool in the slowest manner possible and thus allow the two forces to adjust themselves in as mild a manner as possible.

That steel gets longer is due to two causes. The first is noticeable in small work quite frequently and is due to the rapidity with which the piece is cooled. This is possible from the fact that the cooling surface is much greater proportionately than on a large piece and it is possible to harden the piece to the center.

The larger surface exposed permits of enough surface to harden to overpower the remainder of the heat left in the piece and hold it to the length caused by the expansion from the heat. If we now temper this piece we will find it will get shorter. The other cause of steel getting longer is due to its chemical composition. If a steel is high in manganese it will if heated at a low heat and held at this heat for some time apparently grow or stretch during the heating. It has been my privilege to see this done to the extent that the displacement could be observed very readily with a straight-edge.

Half Time Technical Training

By E. Kilburn Scott

Although there has been much discussion regarding the training of engineering apprentices, I have not seen any suggestions to apply the half-time system. The method of dividing the working day between the work shop and school has been in operation in connection with textile factories prior to the introduction of compulsory education, and with all its faults it has worked very well.

The Evening-class System and Its Objections

The present evening-class system of instruction is practically on the same lines with the difference that the earnest apprentice does a full, hard day's work and then voluntarily attends school in the evening so as to gain that theoretical knowledge which he knows is necessary. Naturally only those with very strong constitutions can stand regular evening-class work. With the majority it means that either the daily occupation must suffer somewhat or else attendances at the evening classes fall off.

A young man may have the best will in the world, but when it is an effort to keep his eyes open, as is so often the case where he has been at work from 6 in the morning, then it will be easily seen that evening-class instruction has its limitations.

Besides mere attendance at lectures and laboratory demonstrations is not enough. Notes must be carefully written up and expanded by reading textbooks, and where a man is at work all day and at the technical institute nearly every evening there is no time for home work.

Other hindrances to evening-class instruction are overtime and being sent away on an outside job. It is true that even with all these handicaps some men have gained a fair knowledge of theory. But they are exceptions; they are the men who would be successful under any conditions. It is the rank and file who require consideration. There is not the least doubt that so far as engineering is concerned the greatest success will be attained by those firms which employ the most and the best trained men and by those countries which spend most in organizing technical education. The great advance of Germany and the United States in industrial enterprise has been primarily due to the thorough training.

In England the universities have been fairly well organized, and the engineering departments of the universities of Leeds, Glasgow, Manchester, Cambridge, etc., compare favorably with any in the world, but they are for students who have both money and time to spend on a proper training.

What is wanted is a better system for reaching the rank and file, because technical training after leaving school is just as necessary as the elementary training while at school.

Evening-class instruction is practically all done in artificial light, and that is not good for the eyesight, while much laboratory work is at a positive disadvantage through it.

A Day-course Arrangement and Its Chief Objection

Partly to meet this and also to enable apprentices and draftsmen to take a portion of the day course, lectures and laboratory demonstrations have been arranged in the late afternoon at some of the universities. At first sight this might seem to get over the disadvantages of evening-class instruction, but the trouble is, that there is a very natural objection to employees laying down their tools in the afternoon. It upsets routine and in the case where an apprentice is working a machine it means considerable expense in having the tool standing idle. I have in mind an apprentice in a foundry who gained a scholarship at the college in the north of England. He could not afford to leave off work altogether, but arranged with his employer to go at 3:30 on several afternoons each week. He was thus unable to be present when the metal was being run into the molds he had worked on all day, and it was not quite satisfactory to either master or apprentice.

What Will Meet the Conditions?

Now the question is, can a method be devised which will enable apprentices and improvers to obtain a good theoretical training while they are serving their time in the work shops. By alternating workshop practice and study day by day it becomes both easy and pleasant to learn both. The method must be such as not to interfere with work-shop routine, or the employers' interests, and it must also not upset arrangements at the technical institutes.

Half-time Apprenticeship System

I think that the half-time apprenticeship system does meet the case very well. The only alterations which it necessitates are that each apprentice job at the bench or machine would be attended to by two apprentices, and the lectures and demonstrations at the technical institute would have to be double banked.

Thus in the morning apprentice A would be in the work shop and apprentice B would be in the technical institute. After the midday meal they change occupations, B continuing A's job in the work shop, A going over the same ground in the institute as B had done in the morning. The load factor of both technical institute and work shop is thus raised.

If a really satisfactory method of practical work-shop training and theoretical training together could be evolved it would be better than taking the training in independent stabs; that is to say, several years at theory and several years in practical work.

Objections to the Alternating System

The sandwich system of about six months' theory and six months' work shop comes nearest to the above suggestion, but it has many disadvantages. For example, it is not convenient for employers because at one part of the year they have plenty of apprentices and at another they have none. It also fails to meet the case of the thousands who have to work for their living all the year round.

The suggestion which I have put forward could be best applied in the case of a technical institute running in closer touch with some large works, or several works could join together to provide such an institute. Those firms which are first to recognize the advantages of giving their apprentices a really sound theoretical as well as practical training in this way will reap a rich reward.

In writing the above I had engineering apprentices in mind, but the idea can be applied to plumbing and practically all technical trades.

LETTERS · FROM · PRACTICAL · MEN

Concerning the Details of making things in machine shops, from the first sketch to the sale

Length of Time Worked and Other Shop Records

"Men are naturally restless. Even if conditions are pleasant most men want to move about once in about so often. It seems to take some extraordinary combination to make a man stay in one place all of his life." The speaker was a man who had been around the country and had worked in many shops as foreman, superintendent or manager.

"I can hardly agree with you to the extent of thinking that all men are restless. I don't think of machinists as being any more restless than, well, farmers or merchants, for instance. Of course, there are restless ones among them." This man was superintendent of the shop where he had been foreman and workman.

The talk became general among the company until one man said:

"How old a man did you ever see working regularly at the trade, and how long in the same place or for the same company?"

"Those are hard questions to answer with any degree of accuracy. I recall seeing a man working at a lathe in the Worthington Pump Works at Harrison, N. J. He was a small, fine looking old man and was the oldest man, judging by looks, that I have ever seen working regularly at the trade. It was during a visit of a number of the members of the American Society of Mechanical Engineers that I saw him. I did not learn his age directly from himself but heard it said that he was past eighty. He was standing up at a small lathe and seemed to be doing his work at a good rate but he certainly did look like a patriarch along side of the others."

Other Opinions

Others in the group had seen the same man and had been impressed with his venerable appearance and by his activity.

"It would be interesting to know how long that man had been working at the business and to know how many different places he had worked during those years.

"It may be that a man is benefited as a mechanic by not staying too long in one shop but somehow or other I never felt inclined to take on a man who showed much of a record in that direction, especially if I needed a steady man. I ran across a man once in Zanesville, O., who had worked forty-nine years for the same concern. He had started in at thirteen.

"Perhaps that statement lacks strictly mechanical accuracy. He had started into a shop. This shop in the course of time had grown and shrunk, and changed owners and moved from one town to another and then back again, and had even changed its name but this man stayed with it, and, judging by the machinery, the shop that he started with was still there regardless of its legal identity. The statement of the time came to me from him and was corroborated by shop traditions as expressed by a number of his fellow workmen. I had been interested in a machine that was so ancient as to be new to me and an inquiry addressed to one of the older men had brought the answer that Fred could tell me all about all of them for he had been there ever since he was a boy. At the same time Fred had been pointed out."

Some Remarkably Long Careers

"I had a funny little experience not long ago. A bright looking man came in and asked for a job. He looked so young that I had doubts about his having had experience enough and so stated to him. He named a number of places where he had worked but the kind of work was not like that done by us although the companies were good ones. I intimated that we did a different class of work and he mentioned some other firms for whom he had worked. I became interested as he had traveled much more than I had and drew him out and finally asked him how long he had worked at the business. Taking his statements at their face value he had not averaged three months at a place even when his apprenticeship was included in the average. I was afraid that he had had too much experience and did not put him on."

"You should have given him a job. Most certainly his experiences as a traveler should have prepared him so that he could appreciate the blessings of a steady job, and then you would have received the results of the accumulated experiences of all of these other shops."

"Thank you, but I am not hunting trouble. I have been told often enough how I could get proper work if I did it like some other shop or if I used machinery like the other fellow had. This accumulated experience from the other shops was usually handed to me because I was not satisfied with the results that my polished stone was producing with the lay out that was at hand. As Old Bill Stiver used to say, 'If a fellow travels 'round enough he finally gits to be a jackass at all work.' Bill didn't know a whole lot himself, but he knew some things so well that he always had steady work."

"Boys, I think that I have one claim to distinction." Evidently, from the cheerful look and broad smile on the face of the speaker, it was not a disagreeable honor. "I claim to have the oldest, young man, in the country working for me. He had worked for me several years before we knew how remarkable he is. He began in a foundry in Wales and has worked at a number of trades besides his present one. He has also worked in quite a number of places and it is very interesting to hear him tell of his experiences.

"A number of the boys became so interested that they would ask for details and they got others of the boys interested. One of them began keeping a record and if this record is right this man, who is now about 43 years old, has worked in the neighborhood of 103 years since he was 11 years old. He is quite a bit ahead of the next best one who had worked 61 years by the time he got to be 35 years old. If any of your shop records show anything more remarkable than that you can have my place in the hall of fame."

"It may be that the time that he worked in each of these places seemed as long to him as the time he stated to the boys. You may understand that he was not trying to deceive anyone but his sensations had been so intense that he lost track of the real lapse of time and judged of it from his feelings." The philosopher was evidently waking up to the occasion. "I suppose you all know how some men are like that when putting their time on a time sheet. They charge up a lot of time on the disagreeable jobs and do not have any left for the ones that they like to do.

Unreliability of Memory

"That is what makes lots of time sheets so very unreliable and then some people get mad about it and think that the men are trying to fool them.

"It seems like an awful long time when you are working in a hole and have to lie on the flat of your back and get cramps all over, but when you are resting and the other fellow is doing the work in the hole the time passes very quickly."

"Your explanation may be all right but I think that it is more likely that your great worker did not have any sort of a record of the time worked in each place and so just guessed at it, and maybe he even guessed at the places where he had really worked. If you care to test your

own memory for accuracy just think back to some things that happened some time ago and try to tell when the time was, and then look up the records. It has happened that customers would come in and want some past job duplicated without having any very clear description of it and we would try to locate it on our records. They would try to help by telling how long it had been since the job had been done. In most cases it would be found that the job had been done much longer ago than they thought. In one case a man came in and wanted a machine rebabbitted. He also wanted a better babbitt used, but was told that the best had been used. This he disputed for he said that the machine had run a year when new before having been rebabbitted but had not done more than half of that with our work, although he admitted that he had lately run it day and night part of the time.

A Case in Point

"Our records showed that we had rebabbitted it twice before and that it had lasted more than two years each time. The last time, which was the one that he had complained about, it had lasted over twenty-seven months. He hunted up his own bills and found the date when he had bought the machine and also the dates when he had paid us for the work before he felt convinced. As he had never had any trouble with our work the time it lasted seemed short. This forenoon a man came in with part of a machine which he had bought from us and wanted some repairing done. He said that he had had it for three years but the records showed that it was more than seven years and six months since it had been delivered to him. He had guessed at the time without having anything to fix his guess by. The more quickly a record is made after a thing happens the more likely it is that it is right. If your men each have to put in a time slip and you want it to be a record of the work done see that they mark down each job as soon as it is done. If you see to this you may not have to wonder how it is that a man will take an hour to bore a hole four inches in diameter and six inches deep one day and then bore one three and a half inches in diameter and twenty inches deep in three-quarters of an hour some other day. Where the men put in 'guess' slips just watch the time on the last jobs put down.

"But do not forget that it is well to remember and keep in mind the ultimate reason for these things. Shops are places which are built for the purpose of doing work of some kind, and when I say doing work I do not mean simply expending energy. Shops must produce something that can be turned into money. All of these systems of keeping time and of doing other things in running the shop are only helps to that end."

Some Influencing Factors

One of the group gave a very sarcastic laugh, and the speaker could not help laughing a little himself. "Well, then, in the interest of my friend here," and he waved his hand at the amused one, "I will say that these things should all be helps in getting out the product.

"I have understood that there have been people so circumstanced that they are inclined to doubt that the designers of some of the systems in use ever had any ideas like that on the subject. I pity a foreman who has to work under so much and such important system that after it is attended to the men do not have much energy left to get out the work. Even such a simple thing as putting in a time sheet can be so enlarged on that the men devote an altogether unreasonable part of their time to getting one in that will suit the 'powers that be.' It may be that the way some of these things are managed have quite a bearing on the fact as to how long men stay in a shop.

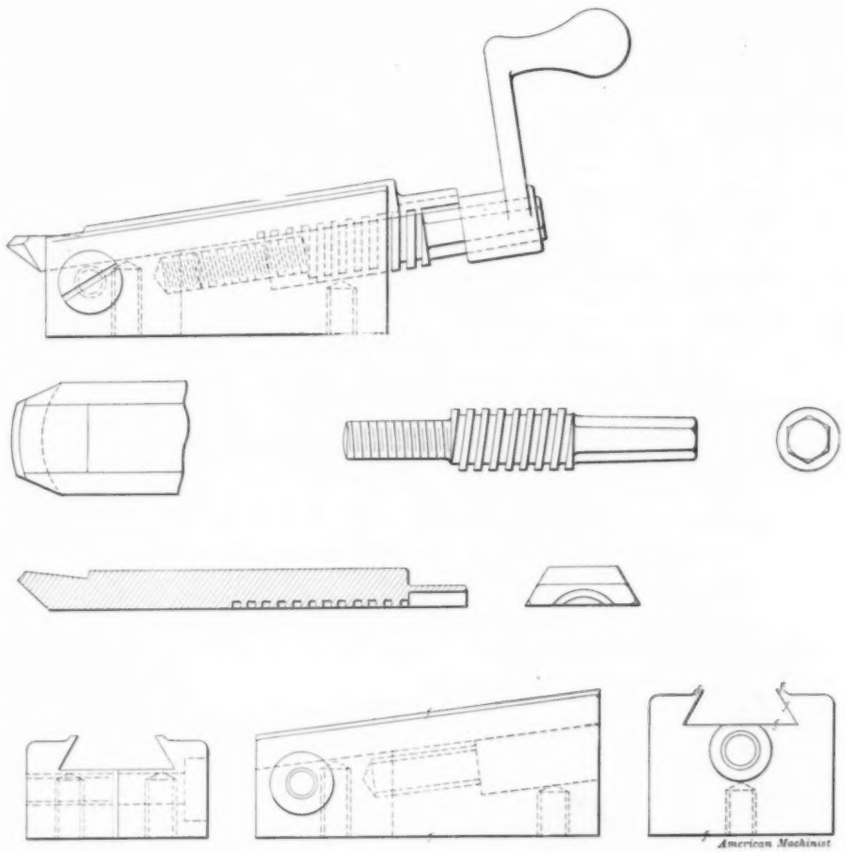
As the group began to break up, one of the younger men remarked, "I see that I will have to get a number of books on psychology, and such like or I will never be able to keep up with this bunch. It's funny what an awful lot of things some fellows have to know to run a machine shop."

Oil City, Penn. W. Osborne.

An Inclined Knife Edge Clamp

The illustration shows an improved form of inclined knife-edge clamp such as is frequently used in the construction of profiling and milling fixtures for the location and retention of work upon the fixtures.

The base of the clamp is made of cast iron, finished on the bottom and in the dovetail groove. It is also slotted vertically with a 1/16-inch cutter, and tapped and counterbored, as shown in the detail of the base.



An Inclined Knife-edge Clamp

The knife-edge slide operates in the dovetail groove. It is made of tool steel, machined all over and hardened at the knife-edge end This slide is operated by the action of a right- and left-handed screw, the smaller portion of which screws into the clamp base, and the larger portion meshes with threads in the wedge slide.

A cast-brass or malleable-iron socket handle is fitted to the slide screw, and may be rapidly detached while in operation, to prevent interference of the handle with the machine or cutters.

A brass shim of the proper thickness is introduced into the vertical slot in the clamp base, and a case-hardened steel screw is used to compress the forward

end of the clamp, in order to compensate for wear on the slide.

The operation of this clamp is extremely rapid, due to the right- and left-handed screw transmitting motion to the slide at double speed, and the device is composed of a minimum number of parts, none of which are difficult or expensive to make.

The small apron at the right-hand end of the slide prevents chips from getting into the screw threads and causing the clamp to work hard.

The angle between the base line and the dovetail groove is 7½ degrees, which has been found to give very good results in preventing the piece being clamped from lifting away from the supporting pads or studs.

Several of these clamps are often used on medium-sized work, and each one should be so placed that its thrust will be counteracted by solid metal in the piece being clamped, in order to prevent springing the work.

Toledo, O. C. NOSRAC.

Press Tools for Forming Tubular Work

The accompanying sketches show a die with different punches for the "funnel," a section of which is shown in Fig. 1, and which is used extensively in the manufacture of "loose leaf ledger" devices. As it was required to form these "funnels" in different lengths up to 36 inches, and the ram of the largest press available only offered 9 inches of support to the cast-iron punch holder *D*, so that the punch could safely form only about 11 inches at one stroke of the press, the die and the various operations will probably be of sufficient interest to the readers of the AMERICAN MACHINIST to warrant describing them.

The die bed *A* remains the same in all the different operations. It is made of machine steel, machined all over and milled out to receive the tool-steel die-blocks *B*, of which there are 12, 6 on each side. These die-blocks are finished all over except on the working side, the holes for the screws which fasten them to the die-bed are drilled and the ends are squared up, so that when they are in place, they form a continuous piece. Now the assembled die is put back in the miller and the working face or inside of the die-blocks, as well as the bottom seat, reaching into the machine-steel die-bed, is finished with a flycutter in several cuts. The die-blocks are then removed from the bed, hardened, and screwed home. It is obvious, that the die-blocks could not be made in one piece as they would spring badly in hardening. This with the exception of a gage, not shown, finishes the die.

The punch holder *D*, made of cast iron, and also remaining the same for all operations, is so simple that it hardly requires any explanation. Punches *C E I* are made of tool steel and left soft. Fig. 2 shows the inside mandrel, used on all operations except the first. This mandrel is about 40 inches long and is made from a piece of cold-rolled steel.

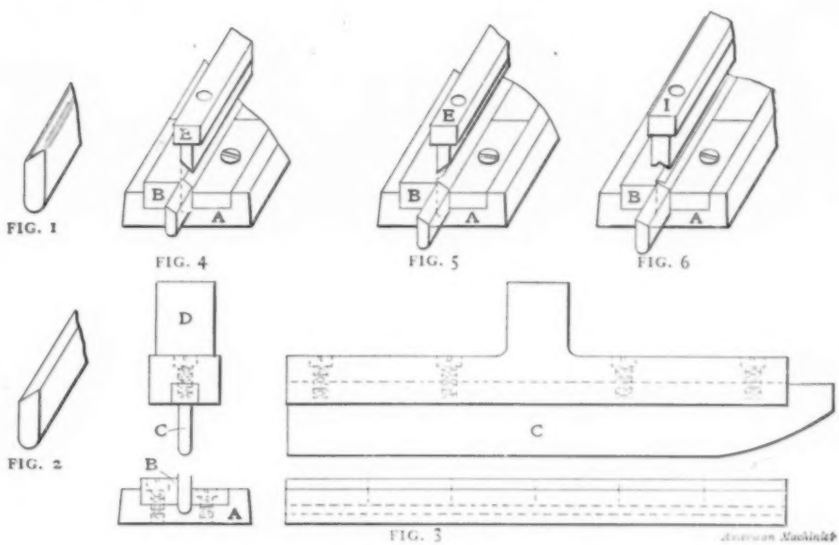
In order to produce the tube or funnel, we proceed as follows: The flat pieces of strip-steel are cut off to the desired lengths with an ordinary cut-off die, and the bending die is set up as in Fig. 3, using the punch *C* for the first operation. Should the funnels be much longer than the punch, the first bend is taken in the middle of the blank, then the ends, making three strokes of the press. The reason for doing this is, that if the bending were started from the end, an error, however slight, would multiply to such an extent that the funnel would leave the die in an uneven condition, or as the boys would say, "lopsided." Should the funnels to be bent be very long, the same method is pursued and the bends are always made from the middle of the stock, and are gradually worked toward the outside.

As this operation leaves the work in a somewhat uneven condition, owing to the fact that the stretching of the metal has been uneven, a flat piece of steel, the same thickness as the mandrel, is placed between the walls of the funnel and the jaws of a bench vise are closed down on the uneven places. This operation does not consume very much time, and the smallest boy in the shop can attend to it, holding the funnel with the flat piece of steel in his left hand, while working the vise-handle with his right.

For the second press operation refer to Fig. 4: The inside mandrel, Fig. 2, is dropped into a funnel, both are placed in the die as indicated by the sketch and the punch is brought down, working from right to left. In order to proceed with the third operation, Fig. 5, we reset the die, turning the punch which is the same as in the second operation around as shown, also using the mandrel. This operation bends the high edge over far enough to bring it within easy reach of the closing punch shown in Fig. 6. Fig. 6 shows the finishing operation, which closes the funnel and takes out the slight curve produced by the uneven stretching of the metal in the first operation. In order that the mandrel will not stick in the last operation, which closes the metal firmly around it, the mandrel should taper slightly and should be greased occasionally. Before withdrawing the mandrel after the last operation, a light blow is struck with a mallet along the high edge of the funnel, making it easy to withdraw.

It goes without saying, that this method of forming these funnels can be improved upon to a large extent, if the proper kind of machinery is at hand. It may also be in place to state, that the various operations require careful handling on the part of the operator or the result will be a considerable amount of spoiled work. If it is taken into consideration, however, that many thousands of feet of these funnels have been produced with this set of tools at a cost of 1½ cents per foot, whereas the lowest figure obtained from a firm equipped with the proper machinery was 4½ cents per foot, it will be apparent that the handling of the work in the manner described was justified from a financial standpoint.

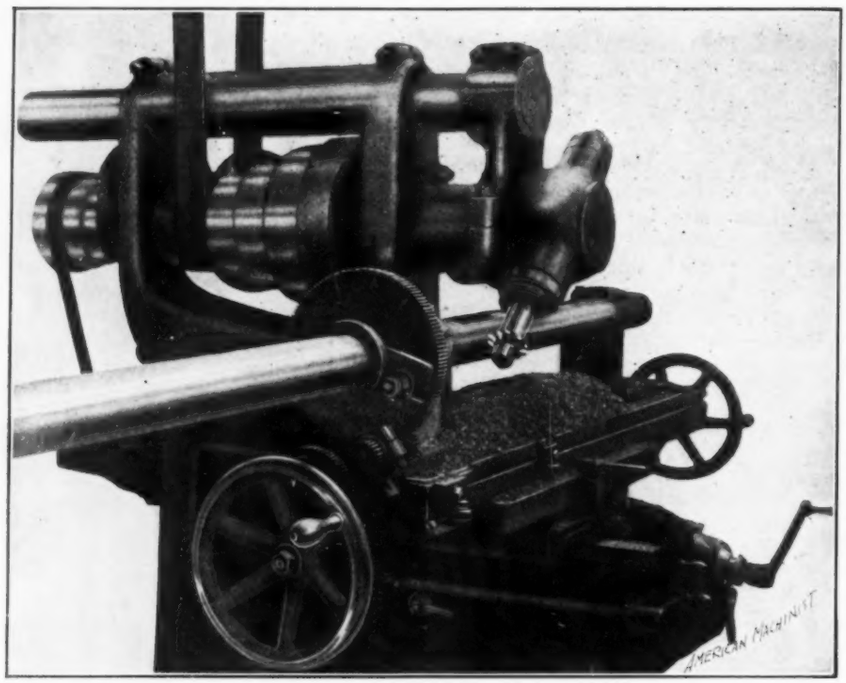
Jersey City, N. J. FRANK GREINER.



PRESS TOOLS FOR FORMING TUBULAR WORK

A Spiral Cutting Job on a Plain Miller

The photo shows a spiral-cutting job we are doing on a Kempsmith plain milling machine with vertical attachment, by driving with a special indexing head.



CUTTING SPIRALS ON A PLAIN MILLING MACHINE

The spirals run from 2 feet up to 9 feet in length, 3¼ inches outside diameter, 5 pitch, 11 teeth, 45-degree angle. We are cutting them at the rate of 1 foot in 67 minutes, using a high-speed steel cutter.

We expect to reduce this time to less than an hour per foot by putting a larger pulley on the line shaft.

The special attachments were made at comparatively small cost and we think this makes a very efficient combination for producing this work.

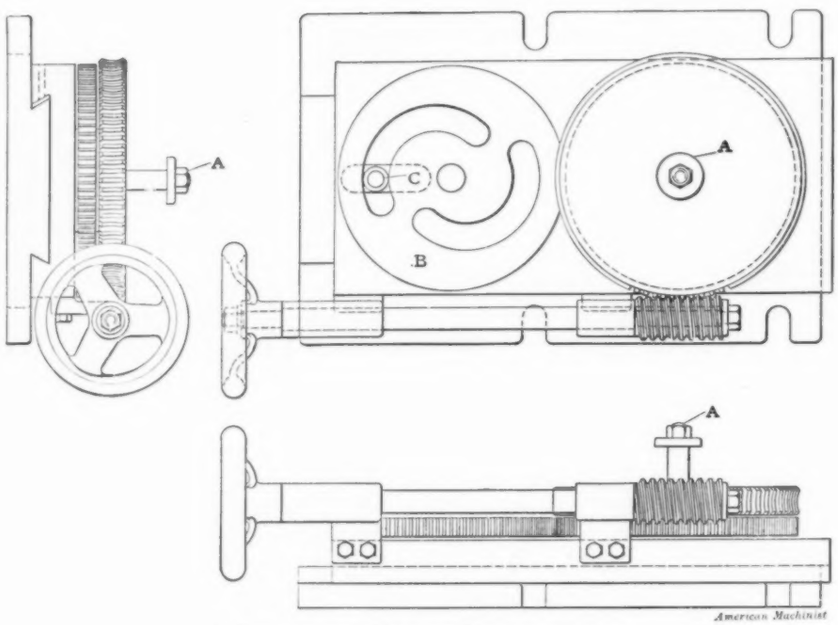
Moline, Ill. WILSON P. HUNT.

A Cam Milling Fixture

The accompanying line cut shows a cheap and efficient cam-milling device to be used on a vertical-spindle machine, or in connection with an angle plate on a horizontal-spindle machine for milling double-throw nut box cams.

The blanks to be milled are held on the work spindle *A* with suitable stops or clamps arranged to prevent the work from turning on the spindle. The rotary motion is obtained by means of the worm and worm wheel shown. The lateral motion is given by the master cam *B*.

The worm wheel upon which the work is held and the spur gear beneath rotate together, the latter meshing with teeth cut on the periphery of the master cam, and all turning on studs held in the top slide of the fixture. The stud *C* is secured in the bottom slide, passes through a clearance slot in the top slide, and into the slot in the master cam.



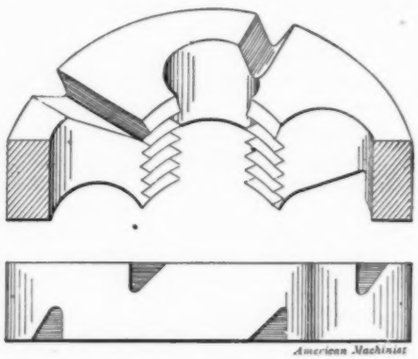
A FIXTURE FOR MILLING NUT-BOX CAMS

As the master cam is made to revolve the top slide moves on the bottom an amount equal to the eccentricity of the slot in the master cam, thus giving the throw to the cam being milled.

Cincinnati, Ohio. J. F. MIRRIELEES.

Grinding Threading Dies

The sketch shows a method of preparing a threading die so that it can be ground without being split in two. A solid die when it becomes dull has to be split in order to get at the teeth to grind them, and this is not a very satisfactory way, as you cannot even then get an emery wheel small enough to go between the teeth. I have had quite a number of solid dies which were dull and needed grinding, but we did not wish to split these, because it is very hard to line them up again. In order to avoid this we devised this new method. By grinding the slots with a disk emery wheel it enables us to grind down the cutting teeth to about one-half the distance through the die, and by reversing this, the same operation can be performed on the opposite side, thus giving life to both sides of the die. We have found this method to be very successful.



DIE ADAPTED FOR GRINDING FROM BOTH SIDES

Chicago, Ill. JOHN M. LARSON.

? DISCUSSION of the PREVIOUS QUESTION ?

Letters from our Readers showing how many Men of many Minds look upon Various Subjects Opened up in previous Numbers

Gearless Positive Speed Changing Device and Draftsmen's Kinks

I was much interested in the speed change described by H. M. Russell, on page 783, Volume 32, Part 2, but when I had puzzled out the action I was doubtful whether the velocity ratio would be constant during the whole revolution. However, by reducing the mechanism to skeleton form, as in Fig. 1, *G A D* and *C B D* being two positions of the links, it was easy to see from the properties of the circle that the angle *A D B* must always be double the angle *A C B*, i.e., in whatever position the gear may be, the angular velocity of the driver is always twice the angular velocity of the driven.

It then occurred to me to make the apparatus quadruplex instead of duplex, as Mr. Russell has done, and by putting the cranks all in the same plane, I arrived at Fig. 2. Here *A* is a crank disk keyed to the driving shaft, carrying four crank pins *B* which transmit the

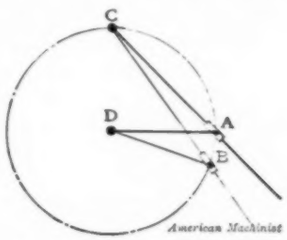


FIG. 1. DIAGRAM ILLUSTRATING RELATIVE VELOCITY OF MEMBERS OF GEARLESS SPEED-CHANGING DEVICE

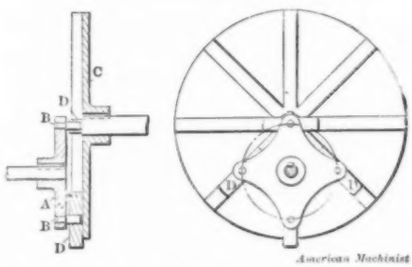


FIG. 2. GEARLESS SPEED-CHANGING DEVICE

force to the disk *C* on the driven shaft through four blocks *D*. By this means the sliding action of the blocks doing the most work is made less, and consequently the efficiency higher than in Mr. Russell's arrangement. In addition it appears to be a cheaper design. Of course, two similar movements could be coupled up in a case on trunnions to get Mr. Russell's 4 to 1 forward motion and 3 to 1 reverse.

Such a gear could not be expected to have a very high efficiency, for even if it were provided with six crank pins the sliding action would be greater than in an ordinary spur gear, but it should be silent even after wear had produced a considerable amount of back lash.

With reference to T. S. Quay's letter, on page 481, and Professor Sweet's comments, on page 841, Volume 32, Part 2, it may console the former to know that I, at least, have made use of his suggestion. But I was not content with a loose piece of tracing cloth. I used my 45-degree celluloid triangle, as shown in Fig. 3.

The quarter circles are sufficient for most purposes. They are ¼ inch apart. The outer circle is divided into degrees commencing from lines drawn through

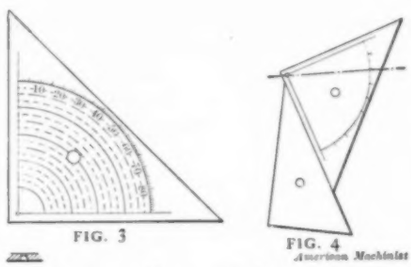


FIG. 3 FIG. 4

TRIANGLE USED FOR PROTRACTOR

FIG. 5. TAPERED RULES USED FOR DRAWING DRAFT, ETC

the center hole parallel to the sides of the triangle. The lines are scratched on the underside of the triangle, the figures stamped on the upper. Used as in Fig. 4, I find this a more convenient form of protractor than the usual one. The triangle is simply laid on any convenient horizontal or vertical line of the drawing at the required angle and then transferred with the aid of another T-square in any direction.

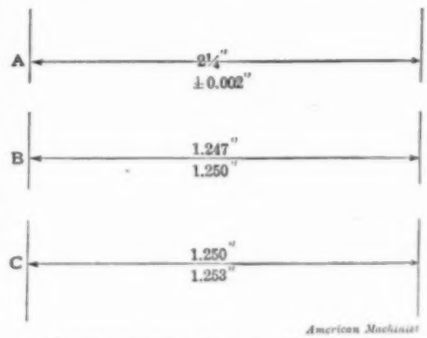
I find the taper slip, shown in Fig. 5, a great help where draft is required to be shown on castings, but have not seen it used by others. I have a set of three for different tapers. They are laid upon the T-square for horizontal lines and between the T-square and the triangle for vertical lines.

G. RATTENBURY.

Rutherglen, Scotland.

Dimensioning Detail Drawings

With reference to the recent articles under the above heading, I should like to offer a few remarks or suggestions. At page 748, Vol. 32, Part 2, H. Pearman in trying to get to the "root of the trouble" asks the very pertinent question, "Are draftsmen sufficiently acquainted with modern machine-shop practice?" A small



DIMENSIONING DETAIL DRAWINGS

detail drawing accompanies the query and the obvious answer is, they are not! For myself I would say that, if, as seems to be inferred, "current machine-shop practice" means the various methods of the various men, then it is not to be expected that the draftsman can be sufficiently acquainted with it. His duties comprise the designing of the product, the making of the necessary drawings, and the dimensioning of the same. That the dimensions should be given in an intelligent manner goes without saying, also, they should be given in such a manner that the men may get to work with the least amount of trouble.

To this end I would suggest that the foreman machinist be asked to assist in the checking of the drawings from time to time. He will then see to it that the details are dimensioned in the way which will help him to start on the job in the quickest time. This will be, in a way, educating the various parties concerned. The draftsman will learn more of the methods of the shop, the foreman will have a better understanding of coming jobs, before he actually has the handling of them, and the men themselves will be rendered more efficient, by reason of the coöperation or collaboration of their superiors. This collaboration will be profitable also, because, the foreman may suggest modifications in design which will enable him to handle the product in the most efficient manner with the plant at his disposal.

With regard to men taking fright at decimals, and spending time finding out the meaning of them, this would appear to be overstating the case, because if a dimension is given, as by the correspondent referred to, as a vulgar fraction with with a decimal tacked on, and a plus or minus sign $\pm$, if the man has to find the meaning of the decimal given in this manner, surely it should not be a difficult matter to read the whole dimension as a decimal. All he has to do is to forget what vulgar fractions are, read his decimal dimension from the drawing and then use his micrometer and obtain the same reading with that. I might here remark that if scales only were used which did not have binary divisions of the inch but were graduated decimally, the trouble would disappear automatically.

Also, supposing a workman did not understand his drawing or its dimensions, ought he to start work? I should say not. His obvious duty would be to consult his foreman at once.

To start work without an understanding of what is wanted is courting disaster. It comes to this, then, that the foreman should be the real link between the drafting room and his shop, between the draftsman and the machinists. With a little tact and judgment this would be mutually advantageous.

Mr. Pearman expresses himself as in favor of dimensions being marked as at *A* in the sketch; this, although it may be all right in some instances, would not do for all cases, as, in almost all cases where there is a tolerance it is definitely stated whether the tolerance itself is above, or below, the standard size. For instance, shafts may have their tolerance given as at *B*, and holes may have their tolerance shown as at *C*.

It follows from this, that the best plan is to mark all dimensions decimally, with maximum and minimum dimensions, then the workman knows exactly what he has to depend on, just what his tolerance is, and whether above or below the standard size. Here again the desirability of collaboration will be evident, because the foreman will be able to impart to the draftsman some of his knowledge of his methods, material and men.

WILFRED GEORGE.

Manchester, England.

Design of a Chuck Key

F. Reuter's statement on page 565, Volume 32, Part 2, that he *increased* the strength of the chuck key by his method is wrong. He really decreased it. Solid square girders with two of the sides vertical are 1.444 times stronger than similar girders with one diagonal vertical. The wrench which broke was 41 per cent. stronger than the one which was made later.

Madison, Wis. C. M. CONRADSON.

Machining an Automobile Cylinder

On page 857, Volume 32, Part 2, of the AMERICAN MACHINIST, James McIntosh states that the ideal condition would be to finish the bore of a cylinder at its working temperature, but that being impossible, we may be safe in assuming the nearest approach to that condition as best. I can hardly agree with Mr. McIntosh as to this ideal condition being an impossibility. I propose to circulate water through the jacket of the cylinder, the temperature of which is to be the same as it is in the radiator under average conditions. The keeping of the water at an even temperature while circulating through the cylinder can be done by a little experimenting.

A very well known British automobile manufacturer whose output of cars each year is among the largest in England, has used and, as far as I am able to learn, is still using this process in the following manner: The cylinders are first rough bored without any water passing through the jacket, then the cylinders are transferred to a Heald cylinder grinder for finishing. It is during this grinding that the water is circulated through the water jacket at the desired temperature which, of course, must be kept constant.

It is understood that the cylinder after being rough bored has all the machine work and assembling done on it in order to make the necessary connections to the water jackets for the water circulation. This would probably appear to be a disadvantage to some manufacturers, inasmuch as it necessitates returning the cylinder to the grinding department after being assembled and this increases the cost of manufacturing somewhat. But I think the results obtained will pay well for the extra cost of manufacturing. I believe there was an article in the AMERICAN MACHINIST a few years ago about this particular concern and its process of grinding automobile cylinders.

Cleveland, O. A. W. RITTER.

Gyrostatic Action of a Bicycle

I was pleased to see Mr. Long's letter on page 787, Volume 32, Part 2, explaining the true principle of steering a bicycle, but I think he makes a mistake in describing the acting of the principle. He says: ". . . . he moves a little to left side of the saddle. This causes the frame to tip a little to the right. . . . ."

To make the frame tip to the right the weight must be put on the right of the saddle. If Mr. Long will watch a cyclist rounding a corner he will see that he leans toward the inside, the same as the frame.

In connection with this principle I might call attention to the roller skate, as in this case there is no other method of steering. Each pair of wheels is pivoted on an axis inclined down to the middle of the skate. If the weight is put on the right, the lower part o the axle of the wheel moves to the right relatively to the skate.

As the axis about which it turns is inclined, the wheel in so doing also turns about an imaginary vertical axis and so the axles of the two pairs of wheels converge to the right. An examination of any pair of roller skates will make the action clear. FERNO.

London, England.

Wages, Hours and Cost of Work

The article on page 919, Volume 32, Part 2, by Dixie I think has opened up a good field for discussion. His experience with the toolmaker is one that almost all foremen and superintendents have been through at some time or other.

But take, for instance, the mechanic who has been educated to do his work accurately and spare no pains in putting a fine finish on it. Such a man is able to hold his job only because he is capable of doing this. The finishing becomes as important as any other part of the work.

If for some reason or other he gets into a shop where nothing but accurate work is required and all polishing and fine finish is condemned, he has got a mighty hard "row to hoe."

There are men who are able to do both classes of work, but they are few and far between. Because a job glitters and sparkles like a 50-cent diamond is no sign that it will fill all requirements in a mechanical way. I was at one time working in one of the large factories in the East making a line of machines requiring interchangeable parts, necessitating the building of numerous jigs and fixtures. One morning we had a new toolmaker on the job and from his appearance and kit he sure looked the part of a first-class mechanic.

The first job he got was a drill jig which, from all outward appearances while building it, looked as though he was there with the goods. When done it was polished and frosted and I believe, if I remember rightly, the screw-driver slots in the screws were all in one direction, but oh, my! when that job was checked up it was a fright, and fit for the scrap pile only.

To get back to the original subject, will say that to get hold of a man who is really a good all-around toolmaker and can adapt himself to any class of work from the accurate, firmly finished job, down to a quick, rough makeshift is very difficult, at least such has been my experience.

Buffalo, N. Y. A. DANE.

The Ethics of Memorandum Making

On page 784, Volume 32, Part 2 of the AMERICAN MACHINIST, Graphic expresses a desire to exchange views on the above interesting subject. Here are mine plus my experiences:

First, I tried a small note tablet glued by the back to my desk so that it was always in place and so that filled sheets could be easily torn off. This was all right as far as it went, but it didn't go far enough. I was ambitious and desired to group and index my notes as well as to record them. I replaced the tablet after a time by long slips of foolscap, with headings, clipped to my desk under spring oil covers, and this lasted me till I fell a willing victim to the siren charms of the "tickler" system.

My "tickler" was a 6x9-inch cloth-covered pamphlet box containing two sets of tabbed guide cards headed with the names of the various departments and officials in the factory. The sets were alike in heading but of different color, one being for urgent notes. Notes were made on loose slips and dropped behind these cards according to subject and degree of urgency. Here at last, thought I, is an almost perfect system, elegant, tidy and elastic, capacious yet portable. When about to see Mr. Blank or to visit shop 3, all I had to do was to go armed with the sheaf of notes from behind the Blank or No. 3 guide cards. What could be simpler? But, somehow it didn't work.

One objection was that a glance into the box would not reveal its contents, the notes had to be removed and examined. Further, the nonurgent department soon became choked with memoranda of things partially settled, things indefinitely postponed and things that never would be settled. Some notes were difficult to classify and hence hard to find; and thus they were lost, for if one knew what note to look for, there had been no need to have made it. In short, I found "out of sight out of mind," and that the easiest way to overlook a matter altogether was to consign the note to my tickler which obstinately refused to do any tickling.

Disappointed with its working, I at last dropped it, but with reluctance, as I felt there was good in it if only we could have got on together. Far be it from me to cast all the blame on the tickler; perhaps it was a case of incompatibility of temper. I used to call it names for sulking and withholding information, while the stony silence it maintained only served to irritate me further.

Then I tried trays. I secured six trays and labeled them as were my guide cards. These would receive not only notes, but a bundle of letters, a casting or a tool concerned in the matter to be discussed or written about, and to this extent were an advance on my tickler box. Also, the notes were more easily seen and reached. Whether Mr. Blank came to see me or I went to see Mr. Blank made no difference; in the latter case I merely collared the Blank tray with its contents and took it with me, and I am still of opinion that my tray scheme was a good one and ought to have worked. But it didn't.

My tickler had been too close and secretive; my trays were too frank and open. They embraced more than intended. Tools and parts which had no business there strayed into them, and fate in the guise of an office boy made mysterious and puzzling rearrangements of their contents. Thus I frequently got half way through a report to Mr. Blank only to find that it should have been made to Mr. Dash. When my tickler had failed previously, I made and filed my first note on note making; it read: "Caution—A notebook or box must be easy of access."

When my trays followed my tickler out of my sight, as they very soon did, I made my second note on note making; it read: "Caution—A notebook or box must not be too easy of access."

This was when I took up the 6-page pocket folder with inserted sheets described by Graphic, for whom I can't help feeling sorry, knowing what is in store for him. I was attached, in two senses, to this folder for some months but after much physical effort and mature reflection I abandoned it and now see nothing to recommend it except its capacity when carried on the person to ward off an assassin's knife. It forms quite a package and I should certainly use it in Barcelona. True, as Graphic says, it is not *much* trouble to change filled sheets for blank ones when you have the others handy—which is generally when you don't want them. But experience has shown me, and will yet show Graphic, that the ideal system must give no trouble at all. It must be self-supporting. Human nature is weak and nine out of ten systems of memorandum making or clipping filing which require periodical preparation will fail immediately. The tenth will succeed partially in strong hands.

At last after years of endeavor I have evolved a system demanding no assistance from its grateful user and as perfect as it is simple. So simple is it, indeed, that scoffers may be inclined to call it no system at all.

But what care I? As Graphic smiles when his lady friends warn him that note making will weaken his memory, so shall I smile at the scoffers. But, unlike Graphic, I have no "moments of doubt." Now, a child and a wise man may reach the same goal by opposite roads and in like manner some of your readers who have hardly given a thought to this stupendous subject may have instinctively adopted what has only come to me "after many days." Let them be thankful.

This is my system which I offer as a serious and satisfactory solution of the problem: I make my note on a piece of scrap paper and lay it on my desk under my nose. Sometimes I pin it there. I can't miss it. When settled, I crumple it and drop it into a thing called a waste-paper basket. It never fails.

Enshrined in my heart is my third note on note making: "No book or box necessary."

Leicester, Eng. A. T. LEAS.

Lubrication and Accuracy

A striking proof of Mr. Godfrey's contention that there are places where a lubricant won't lubricate is to be found in the Hammond typewriter. You are warned not to oil the type-shuttle race. If you do, it will "drag" and fail to register properly to correspond with the key struck, or fail to fly back when released. A lubricant on the knife bearings of delicate balances would, I think, cause trouble.

By the way, speaking of "Unnecessary Accuracy," isn't the statement that steam at 100 pounds pressure turned into a cast-iron cylinder gives a temperature of 377.6 degrees Fahrenheit, rather unnecessarily accurate? Isn't it possible the heat might actually be 377.4, or maybe only 350? I presume 377.6 is what it ought to be, but is it?

New York. R. J. HEARNE.

Foot Feed for Drills

A recent article on the foot method of feeding the drill recalled an experience I had once with a full-sized machine where the feed was produced in a similar manner. Constant breakage of drills had made this machine notorious and after looking into the matter we decided that the arangement of feed levers was at fault.

This method was abandoned and a lever feed with rack and pinion substituted, the rack being screwed on the sliding head and the lever pinion bearing on the machine face.

This proved successful and seems to be a confirmation that the "pull" is more sensitive than the "push." This method is, of course, very handy in itself as it leaves both the hands free.

Leicestershire, Eng. ERNEST MEE.

Twist Drills and Their Tangs—Experience with Accurately Fitted Taper Shanks

I have read Mr. Halsey's remarks on the above subject on page 26, Volume 32, Part 2, and should like to say that, after re-reading my remarks on page 774, Volume 31, Part 1, I am still of the firm conviction that sidetracking in search of keys, patent sockets, etc., will never obviate the trouble with the tangs unless the root of all the trouble is remedied, by making the spindle hole and twist-drill shanks an accurate fit for the Morse gage and therefore for each other.

My remarks referred to explain very fully the conclusions arrived at after long experience and I make bold to say that, given an indifferently fitted taper shank, the Sellers system key will be useless unless when the drill is at work. Take the cases cited on page 774 above referred to, if the drill is in either of these conditions, the shank will have traveled far enough to have only a slight hold on the key and may even travel far enough to get away from the key altogether. Will Mr. Halsey say what will happen then? If he always arranges that the shank is an accurate fit then I reply that the key is useless for driving purposes as friction will drive all that the drill is able to take. The key, however, will prevent the taper hole from being damaged in exactly the same way that the tang will and no one will question which is the cheaper to make. I have drilled many holes in cast steel with a 1¼-inch drill which had *no* tang, it having been twisted off in the manner indicated on page 774 and the holes were drilled to determine whether the buyer or the seller was to stand the cost of a replacement, claimed because of the twisted key.

I am rather disappointed that the makers of twist drills have not yet seen their way to give us the benefit of their opinions or the results of any tests they may have made in this direction. Perhaps they will now engage in this discussion for the benefit of your readers. A draw-back bolt or something of this nature is the only real solution of this difficulty, combined, of course, with accurately fitted shanks, as they would do away with the tang on the drill and also the cotter hole in the spindle. They would lock the shank firmly to its taper seat and make it impossible for the drill to move forward independently of the spindle; they would save much tear and wear on the drills themselves, for who has not seen a newly sharpened drill driven home into the spindle by the flat side of a hand hammer or by thumping the drill and spindle against the work by the wheel or lever of the machine resulting in the drill having to be taken out again and returned to the store as unusable owing to a chip being knocked out of the point?

I am discussing the question in all seriousness as my conclusions have been firmly fixed in my mind after dozens of tests made with a view to eradicating some opinions on this subject as well as to properly allocate the blame for the twisting and abusing of the tangs on the ends of twist drills and I should also say that in most cases it also decided whether the maker or the user was to bear the loss of the ruined tang. In view of these experiences it seems to me to be a useless proceeding to make a multiplicity of chucks or any other tool because of the unsatisfactory working of any one element which, if properly looked into and attended to, would right the trouble itself.

I herewith place before your readers a recent instance which compares favorably with my former experiences and which may prove interesting.

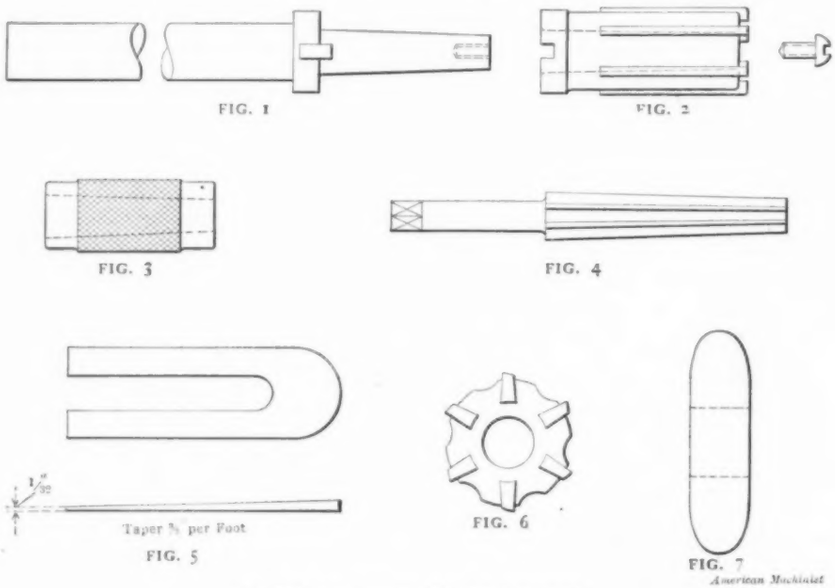


FIG. 1. FIG. 2. FIG. 3. FIG. 4. FIG. 5. FIG. 6. FIG. 7.

American Machinist

CORRECTLY FITTED TAPER SHANKS

Figs. 1 and 2 show a well known type of adjustable-blade reamer and arbor, the hole in the reamer being made to the Morse taper and the arbor tapered at the end to suit the hole. The feather shown is an easy fit in the slot in the reamer, and is, like the tang on the twist drill, supposed to help in the driving. On the Nos. 1, 2 and 3 sizes of arbors and reamers, we had considerable trouble in reaming mild steel and often even cast iron, and, if the feather was not twisted right out of position, destroying the slot in the arbor in its travel, then the slot in the reamer itself gave out and it was some time before the real condition of affairs was understood. Then it was found that the hole and arbor were not perfectly correct on the angle of taper, throwing a good deal of the driving on the feather. In some cases also the reamer went right home and butted against the shoulder of the arbor. It was decided to make taper reamers and gages for the Nos. 1, 2 and 3 sizes, Figs. 3 and 4 (as although the taper is to the Morse angle the sizes are at variance with Morse standard taper sizes) then the arbors were made an absolutely correct fit for the gage, leaving the gage ⅛ inch from shoulder of collar. Reamer No. 4 was then put into the hole in reamer body No. 2 to clean up the hole to correct angles of taper. After this, if necessary, a certain amount was taken off the slotted end of the reamer body and the slot was deepened to leave ⅛-inch clearance between the end of reamer body and the shoulder of the arbor. When put into use the reamer body was driven firmly home on the arbor, leaving about 1/16 inch clearance between end of body and shoulder of arbor also leaving slot 1/16 inch clear of point of driving feather, the feather being perfectly free on sides of slot also. I have not yet seen one of these properly fitted reamers twist or shear its feather nor move into position to require any assistance from the feather in driving.

In fact, the reamer holders became so solid with the arbor that the drift, Fig. 5, was made to separate the reamer from the arbor, being inserted between the collar and arbor and doing its work perfectly. They were made from cast steel, and tempered to straw color. All new arbors and reamer holders are treated in the same manner and whereas before, there was a feeling of distrust whenever any of these were put into use, because of our former troubles, this feeling is now completely gone as the methods adopted have proved so successful in obviating any trouble in this direction. Surely this case is conclusive enough to warrant the opinion that the friction set up by a good fit is able to do all the driving.

Through long use and, it may be, the

fitting of new blades, it often happens that the slots in the mild-steel body which hold the blades become a shade easy for the blades, resulting in their creeping up the body through end pressure and, of course, reaming the hole too large. To get away from this trouble a cast-steel hardened roller, Fig. 7, was made, the convex form of which was made of a larger radius than the concave grooves in the holder, Fig. 6. The holder was then placed on an arbor between centers and supported at certain parts of its length, the grooves were then spun with the roller, making a slack-fitting blade into a thoroughly reliable blade.

Dalmuir, Scotland. ROBERT BROWN.

Home Training for the Prospective Engineer

It is with considerable interest that I read what is said in your valuable paper in regard to the trade schools and why the manufacturers dislike the college graduate. All that has been said on the above subjects I have seriously considered and, to say the least, it has got me into a serious tangle. Some say that our schools are not what they ought to be, that the Germans have got us beat and that we are behind the times to a considerable extent when the mechanical colleges or trade schools of most any of the European nations are considered.

What has caused me all this worry is that we (that is, Mandy and I) have a son whom we have been thinking of sending to one of these trade schools, or possibly one of the bigger ones where they learn to be a mechanical engineer or something like that. When I read that the manufacturers do not want graduates until they have been out of school for at least two years, that they are considerable bother to their employers, I was troubled and, as I did not want Mandy to see these things, I put my paper away thinking that she would not find it; but, to my surprise, she got next that I was trying to hide something from her, and when she gets that notion she will look at everything and read it too. I read some of them to her and told her that they were only critics' opinions. She felt better and I do not look for any more trouble from her. What is worrying me now is that should we have to borrow some money to pay a part of his expenses, and if the manufacturer does not want him for two years after he has graduated we don't see much chance for him to commence to repay us for at least seven years after he has started in college. We would not mind the financial part so much but, when we think that the man whom we have been fitting him for does not want him until someone has trained him for two years, we begin to think that we had better have him learn a trade.

When I see what some of these college professors say about the students it makes me think of Mandy. She believes in having the boy do his own thinking and when she tells him to do some work she stands and watches him. When he fails to strike the right place she will light in and show him how by doing the task. With me it has been different. I believe that a boy should do his own work as well as his own thinking. This has also led up to trouble as the boy has got to thinking that all that is necessary for him to do is to do the thinking and leave the work to take care of itself, so I seem to be having the troubles of the professor.

What strikes me most is the fact that the boys do not seem to be much different in their life at school and at home. If they know how to put up shelf and a clothes line, or repair a broken piece of furniture, refinish the piano, repair the telephone and put in a new fuse after each electric storm they will succeed in school and thereafter. Mandy objected to having the boy do such work, but after he was 14 I resigned as being the head of the house and placed the duties of father on him even to the buying of the coal; in fact everything that had any work attached to it was placed on his shoulders, and it does strike me that he will be one of those engineers some day. If the manufacturer is going to place him at a disadvantage by wanting someone to take him for the first two years after he is out of school, then we think that he had as well go in the shop and take his chance of getting to the top with the rest of them. As I am somewhat short in book learning I am inclined to think that the thing to do is to send the boy to school. If he could but appreciate the need of having an education I presume that we would not have the troubles of the professor in getting him to take hold in school, neither would it be necessary for us to borrow money to pay his tuition. He is now going to school and making $15 per month which, if properly cared for, might be the means of paying his own tuition.

If he does not do this who is to blame? If he does not know the worth of a dollar when he enters college will it be his fault or mine? If he goes to college and the professor thinks that the boy should have one or two years in the shop, is it the boy's fault or is it mine? Do I not have an opportunity to teach him the common things? Again if when he enters college he does not know how to do a piece of wood work, sharpen the lawn mower, repair the hydrant, half sole his shoes, whose fault is it?

We sometimes get the idea that the boy is of but very little use other than to do the things that we do not want to do, and we allow him to grow into manhood, and be a boy who has book learning but none of the practical things of this life that produce self reliance and judgment. As a result when he graduates from our best schools he is not wanted; not from the fact that he does not know the more difficult things but from the fact that he does not know the simple things that are essential to his success. Now I do not expect anyone to ask me to copyright my method but I will explain how I managed him. I do not expect to have to borrow any money, neither do I expect to be obliged to place him in the shop for two years after he has graduated, in order that he may be of value to the manufacturer.

The way that I went at it was this: If there was a loose board somewhere about the place, I always managed to find it first. I would take the boy, show him the defect in the fence, ask him how he would like to have anyone know that he was running the place that way and try to appeal to his pride. I had learned the art of doing my own cobbling and determined that he should share the secrets. When he got so he could drive a nail straight and his shoes needed some new hide on their bottoms, he was taught that it was necessary for him to learn to apply the hide in the proper place. He was given a definite amount of work to do from the blueprint; he was and is given blueprints of machinery, something that he has seen and is instructed to locate each part. He received no help from me, being obliged to search for himself. He must determine when his task is complete; he has been taught to rely on his judgment to know what to do and when to do it. As a result I do not anticipate that it will be necessary for him to enter the shop before he has finished his schooling, neither will it be necessary for him to have two years in the shop before the manufacturer will want him. He has the small things, it is now up to him to get the larger. Give the boy a chance to become a valuable man by giving him the consideration that we would like to have.

Davenport, Ia. C. U. SCOTT.

In a paper read before the Ohio Society of Mechanical, Electrical and Steam Engineers dealing with the power costs for factories it is stated that the steam consumption of steam pumps is often at least five times that required by large central engines driving generators for supplying energy to motors for doing the same work, and in extreme cases, with long lines of steam pipe and intermittent service, the steam consumption has been found to be ten times what would have been required by central units for the same service. In discussion the results of an investigation were reported which showed that the cost of operating a certain boiler plant for steam heating alone, in the winter time, was nearly equal to the cost of running the plant for both the motor service and the heating service combined.

AMERICAN MACHINIST
ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY
JOHN A. HILL PRES. ROBERT McKEAN SEC'Y. 505 PEARL ST. NEW YORK

A Newspaper Lie That Might Mislead

A couple of weeks ago the newspapers published a made up story of a $15,000,000 merger of trade papers that included the three papers of the Hill Publishing Company.

The *New York American*, a Hearst newspaper, called up our president, Mr. Hill, said they had the story "from a reliable source" and asked if it was true.

Mr. Hill declared that it was not true, he had not been asked to go into any such combination and would not go if he was asked—yet they published the story—some of the papers even adding at the bottom of the article Mr. Hill's denial. The sensational heading was allowed to stand, however.

This illustrates how much newspapers care for the truth—they only want the sensation.

Now comes a so-called trade paper, *The Paper Trade Journal*, taking us to task for "going into the hands of Wall Street," and abandoning the things that "built up our papers."

This editor has seateatis and edits his paper from a soft chair and his impressions received in doctored form from the daily papers—he did not even take the pains to call up and inquire. He says, "Naturally the whole story is denied by the men concerned" and intimates disaster when subscribers and advertisers learn that outsiders own the paper, etc.

We need hardly assure our readers that this whole story is a malicious falsehood.

That the Hill papers at least have gone into no combination.

That all our stock is owned by employees and one ex-employee of the concern.

That Mr. Hill owns an overwhelming majority.

And intends to keep it.

This concern has been built up on the line of minding its own business and making the best newspapers that it knows how in the trades it represents.

This policy will be followed in the future as in the past.

We shall "do things" in the publishing line, and "do them first."

This is now the largest independent engineering publishing house in the world—and the whole force from the old man to the last recruit have a pride in keeping it there.

The only "merger" we will ever go into is one that we own and control.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

Hill Publishing Co., Ltd., 6 Bouverie St., London, E. C., will serve all subscriptions for English Edition for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

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January 13..... 30,500

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None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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Vibration as a Factor in Cutting Metal

Most of us recognize the effect of vibration to a greater or less extent and yet, if some of the statements made are correct, we do not fully realize the important part it plays in all our cutting of metals.

The experiments of Hans Renold in England, showing the advantage of a chain over a belt drive due to the constant pull rather than the possibility of the intermittent efforts of a belt, were startling but conclusive. These, however, led many to the conclusion that belts were necessarily bad and that any method of positive driving must be better than belts. This encouraged the advocates of gears for all kinds of drives, and was used as evidence that the belt must be laid aside in practically all cases of machine designing.

Careful students of the question, however, look at this differently and contend that gears and chains are not alike in action, and that a train of gears will not give the steady pulling action of a fast-moving belt of sufficient width. They contend that in the case of a large end-milling cutter, larger than the width of the work, the shock of striking the work is greater with a gear-driven machine, especially one that has been in use for some time, than with either a chain or belt. The case of the lathe is cited, it being claimed that a tool will last longer with an open belt than where the back gear is used, provided the speed is right.

Any back lash, whether with gears or chain, produces vibration and, as has been shown in many experiments, vibration is fatal to the life of any cutting edge. This is claimed to be one reason why high-speed cutters do so much more work on geared machines; they stand the vibrations longer than a carbon cutter. Machines driven by powerful belts and without gears are said to do practically as much work with carbon cutters as others do with the high-speed cutters, owing to the absence of vibration. How far this holds true in everyday work is yet to be determined, but it is a factor worth looking into, and almost every shop can do a little experimenting so far as keeping track of results is concerned.

This is simply in line with the reasoning put forth several years ago by M. James Hartness in his "Evolution of the Machine Shop," from which we quote but a single sentence: "The greatest edge-

destroying action is side motion or quivering, which in most extreme cases may be heard and felt."

Quivering or vibration, even to a very small degree, prevents the use of keen edges on tools, which might easily stand a heavy direct cutting strain, but are broken by a very slight side movement. Whether the back lash due to wear of gears causes a destructive vibratory action on the cutter or not, can readily be determined by a series of experiments that are not difficult to make, as it only involves the results obtained from cutters under both conditions. It is needless to say that in any such test, extreme care should be taken to have both machines of equal power and not to select a belt-driven machine with a belt which is sure to give the intermittent action found so destructive in the Renold tests.

What we are after is not the superiority of any special make of machine, but to know which is the most efficient method of driving milling and other cutters.

A Gleam of Hope

The President's message to Congress contained a section devoted to the law's delays, in which he refers to such delays in our courts as archaic and barbarous. His recommendation is that legislation be provided giving him authority to appoint a commission "to examine the law and equity procedure of the Federal Courts of first instance, the law of appeals from these courts to the courts of appeals and to the Supreme Court, and the costs imposed in such procedure upon private litigants and upon the public treasury, and make recommendations with a view of simplifying and expediting the procedure as far as possible, and making it as inexpensive as may be to the litigant of little means."

Our interest in this, here, is its possible bearing on patent litigation. We are prepared to assume that President Taft will be provided with the legislation that he has asked for and that the commission will result. Whatever good ensues in improving the legal procedure of Federal Courts will be so much done in simplifying a part of our patent procedure. In that there is a gleam of hope.

Yet this is little more than a gleam. What is needed is a most thorough overhauling and investigating of the entire patent procedure and patent system. With the fundamental principles upon which our patent privileges are founded and with the fundamental law that shapes those principles into rules of procedure we have no quarrel. It is the administration of those laws as worked out in our present patent system that needs to be criticized, attacked and changed.

In 1836 public opinion had sufficient force to cause the establishing of a Congressional committee to investigate the, then, patent law and Patent Office. On this committee's report Congress passed the patent law of 1836 and from this law our present statutes are a development.

If investigations and improvements in legal procedure are to have an important place in the program of the present Federal administration, is it not time to develop a united, vigorous protest against certain phases of our patent system, and demand an investigation by some properly constituted commission?

New Publications

HANDBOOK FOR MECHANICS. By F. E. Smith. 328 pages, 5x7½ inches. 127 illustrations. D. Van Nostrand Company, New York. $1.50 net.

As stated in the preface, this is a textbook explaining established rules, which is done in the usual way, and while some of the problems take on a mechanical aspect, the plowing of acres and the walking of so many miles a day are used as examples for the shopman who may have never seen a plow.

The book explains mensuration, specific gravity and has a small section devoted to the mechanical powers, all of which are illustrated by simple diagrams which help to make them understandable. Beams and the strength of materials are also treated in a general way and should prove of value to the man who wants to advance along this line of work.

DRAWINGS FOR MEDIUM SIZED REPETITION WORK. By R. D. Spinney. 91 5x8½-inch pages; 40 illustrations and several tables. Spon & Chamberlain, New York City. Price, $1.50 net.

This little book by an English author, while chiefly intended, as he says, "for engineers who wish to supervise the preparation of detail drawings on repetition work," will also be of interest to others, both in the drafting room and shop, as it contains considerable information on the laying out and handling of repetition work and many helpful suggestions on the subject of interchangeability in shop products, although cheaply made rather than absolutely interchangeable parts have been chiefly considered. Its scope is suggested by the chapter heads which are as follows: Drawings Generally; Standard Lists; Indexes; Tolerances; Dimensioning; Notes on Designing for Repetition Work; Drawing Office Routine.

One of the most useful of these chapters is that on Tolerances, which takes up in detail an explanation of limits and tolerances for various classes of fits, with reference to different types of gages used and numerous examples in practice showing actual limits and tolerances required for specific cases.

An important feature of this chapter is a series of tables giving limit dimensions which have actually been worked to in manufacturing automobile parts. It should be stated here that throughout the book the examples referred to are confined to automobile parts which constitute excellent illustrations of medium-sized repetition work. The chapter on Dimensioning will also be of interest, as it points out ways of figuring drawings so that they can be readily worked to in the shop and with the least possibility of error.

Chapter 6 is a suggestive one to the designer, its 40 pages being filled with notes and general information on laying out work for the economical handling of material and parts; finishing of shafts and other members; design of flywheels, castellated shafts, gears, etc.; application and saving of hand work; use of special tools; commercial assembling.

Personals

Items for this column are solicited.

A. A. Parmenter, for a long time with the Ames Iron Works, of Oswego, N. Y., has accepted a position with the Barnes Gear Company, of that city.

W. B. Engler, formerly assistant chief engineer of the Reliance Motor Truck Company, Owosso, Mich., has assumed the duties of superintendent of the plant.

L. H. Thullen, who has conducted a consulting practice in electrical engineering in New York City, has recently accepted the position of chief engineer to the Triumph Electric Company, Cincinnati, Ohio.

George W. Brill and Horace C. Gardner have formed a partnership for the purpose of conducting a consulting engineering and architectural practice, with headquarters in the Marquette building, Chicago, Ill.

Paul Stoner, formerly connected with the Landis Tool Company, and more recently with the Allis-Chalmers and Cleveland Automatic Machinery companies, has recently entered the employ of the American Emery Wheel Works, Providence, R. I.

John H. Lidgerwood

John H. Lidgerwood, vice-president and treasurer of the Lidgerwood Manufacturing Company, died at his home in Morristown, N. J., on January 1.

Mr. Lidgerwood's connection with the firm dates back to its inception. He entered the employ of the historic Speedwell Iron Works, Morristown, N. J., in 1858, and later, upon the organization of the Lidgerwood Manufacturing Company, he became associated in its management, which he pursued until the time of his death. Mr. Lidgerwood was 80 years old.

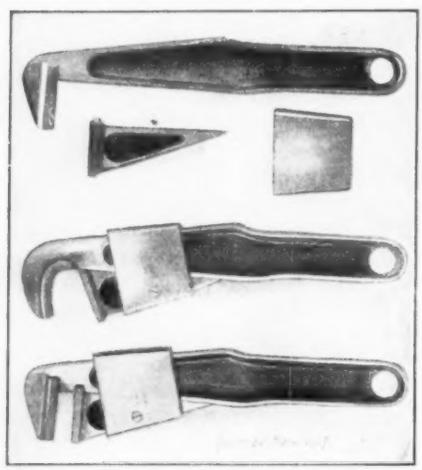
NEW TOOLS and MACHINE SHOP APPLIANCES

Showing New Ideas in Machine Shop Equipment that make it possible to do better work at a reduced cost

A Wrench of Few Parts

This wrench is made up of two drop forgings and a drawn steel sleeve of seamless tubing, a small screw in the sleeve serving to hold the parts together and at the same time allowing the jaw to be readily adjusted to any size by a slight movement of the thumb.

The action is that of a wedge, which grips tighter as the strain is applied, yet



THE "ARPECO" WRENCH

can be released very readily owing to the angle of the bearing surface.

They are made both with pipe and parallel jaws and also in a special thin model, only ¼ inch thick, for getting at narrow nuts in confined spaces. The makers are Rogers, Printz & Co., Warren, Penn.

Townsend Horizontal Riveter

The H. P. Townsend Manufacturing Company, Hartford, Conn., is making a horizontal-type riveting machine. The construction, as far as the principle of riveting goes, is the same as the standard machine, having a revolving hammer, which strikes an immense number of blows by the loosely mounted rolls, which are carried between two disks and which strike of their own weight as they pass by the hammer.

The horizontal machine is especially designed for long work or any work which can best be handled in a horizontal position, such as the heads of fancy hat pins, the ends of metal vehicle-wheel spokes, or rods of any length and which it is not convenient to handle in the vertical machines. The carrying table in this machine is mounted underneath the center of the hammer a sufficient distance to allow various styles of gripping devices to be attached suitable for holding the parts to be riveted. In many

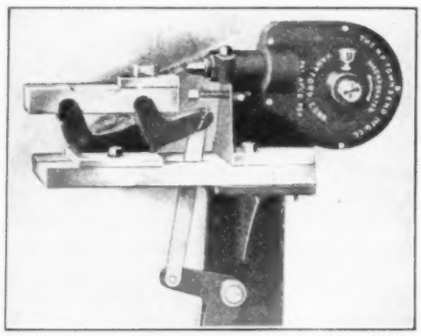


FIG. 1. HORIZONTAL RIVETER

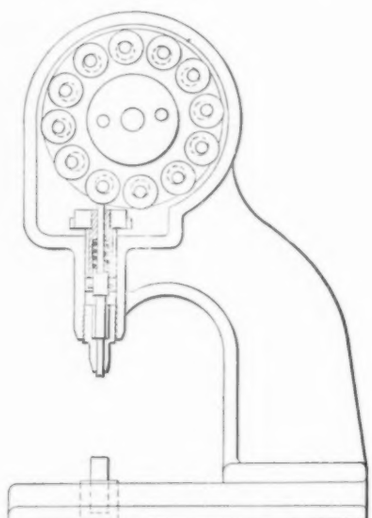


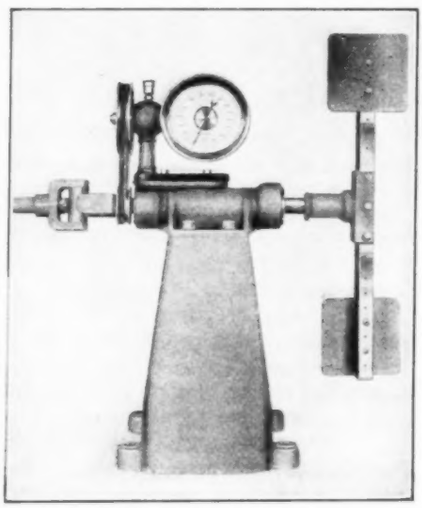
FIG. 2. THE WAY IT WORKS

cases, where a wire has considerable length, it is unnecessary to use any holding devices at all, as, if the end of the wire is simply pushed against the hammer by hand, its own weight is sufficient to act as its own anvil, and the end of the rod will be headed almost instantly, in fact as fast as it is possible for the operator to present the work to the machine. Many other awkward pieces of work besides those above mentioned may be conveniently adapted.

This, as well as the standard type of machine, is adapted to handle rivets from 1/64 up to 5/64 inch in diameter, the variation in the blow required for different sizes being obtained by changing the speed.

Fan Dynamometer for Testing Motors

The fan dynamometer shown has been placed on the market by Joseph Tracy, 116 West Thirty-ninth street, New York.



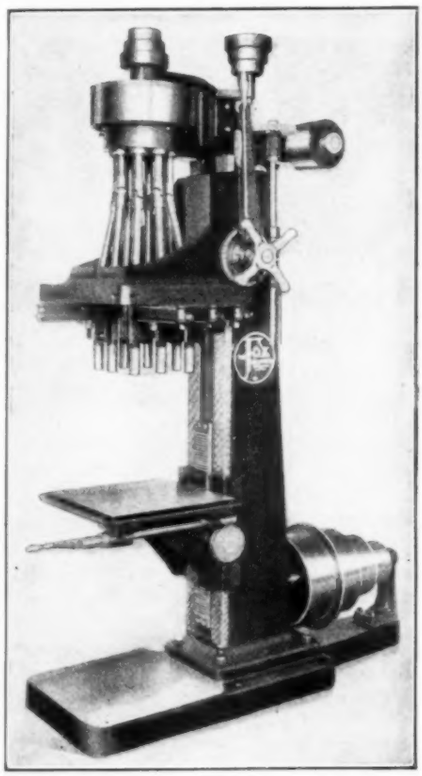
FAN DYNAMOMETER

It consists essentially of a standard carrying a horizontal shaft in large ball bearings; one end being connected to the motor under test by a universally jointed extension shaft, the other end carries an overhung two-bladed fan. A small pulley drives the special tachometer, which is mounted on top of the housing.

This tachometer is provided with a double scale and single pointer; the inner scale showing the revolutions per minute and the outer scale the horsepower developed. The horsepower scale gives a minimum reading of 1 horsepower at 480 revolutions and a maximum reading of 70 horsepower at 1980 revolutions, so that at all ordinary rates of motor speed a simultaneous reading of revolutions per minute and horsepower can be obtained without any computation. It is designed to test motors of medium sized cars, but by the use of fan blades of different area and suitable tachometer scales the range of absorption and measurement of power can be varied between wide limits. Modifications of this are built to test power delivered to the driving wheels. Patents have been applied for.

Fox Multiple Drill

The Fox Machine Company, of Grand Rapids, Mich., is building a line of multiple-spindle drilling machines, designed specially for using high-speed drills. They are built in several sizes, the No. 1 having a table 16 inches square. The base of the machine is 4 feet. The head is counterbalanced by a weight in the column controlled by a rack and a pinion. The column has a vertical swinging shaft which has a worm that engages a worm wheel on the pinion shaft of the



FOX MULTIPLE-SPINDLE DRILL

head. An automatic knockoff is provided which disengages the worm from the worm wheel at the end of a drilling operation. There is also a hand lever provided for light drilling operations.

There are three spindle speeds, from 262 to 1050 revolutions per minute. The feed to the head varies from 0.0038 to 0.0098 inch per revolution of drill spindles.

Combination Vise Stand and Bench

The construction of this vise stand and bench is obvious from the photograph. It is equipped with a 5-inch vise on a rigid tripod base, with or without tray. There are no joints in the framework, which makes for a rigid construction. The vise is furnished in any preferred type, and if with swivel base, a binder for locking it operates in the pocket in front top of tripod. In case a pipe vise is used the shelves form a convenient place for dies, cutters, tongs, etc.

The complete outfit weighs 375 pounds

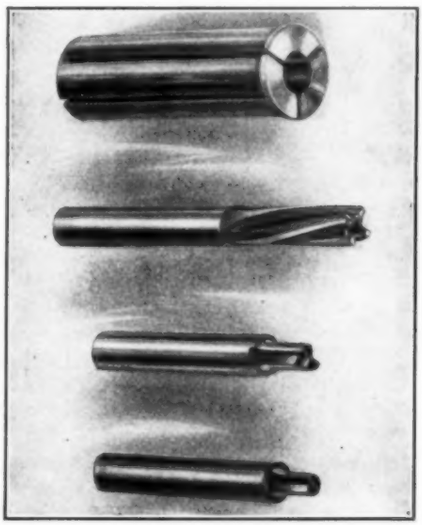
VISE STAND AND BENCH

and is marketed by the New Britain Machine Company, New Britain, Conn.

End Mills

The end mills illustrated in the accompanying half-tone were designed by the Porter-Cable Machine Company, Syracuse, N. Y., for use with their universal milling attachments.

The four-tooth end mill differs from former designs in that it is made up with



NEW END MILLS AND COLLET

less teeth, each tooth having a stronger backing, thus making for better wear.

The single- and double-tooth end mills shown are so formed that they cut to the center which permits them to be fed directly into the work as in drilling, thereby doing away with the necessity of first drilling a hole before using the end mill. These mills are furnished both in high-speed and carbon steels from ¼ to 5/8 inch and 1/16 to ¼ inch respectively.

The spring collet shown in the half-tone is made ½ inch outside diameter in three sizes to accommodate all of the end mills shown.

Micro-Adjustable Boring Head

The Porter-Cable Machine Company, Syracuse, N. Y., has recently brought out the micro-adjustable boring head illus-

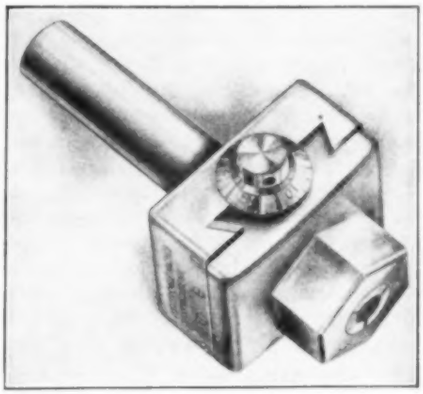


FIG. 1. MICROMETER-ADJUSTABLE BORING HEAD

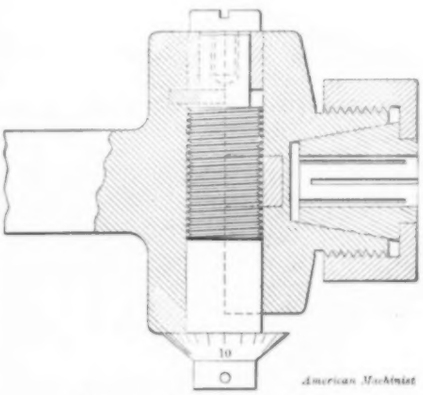


FIG. 2. SECTIONAL VIEW

trated herewith, which has been found useful in connection with their universal milling attachment in the accurate boring of small holes in jigs, fixtures, dies, etc.

In Fig. 1 is shown the completely assembled boring head, while Fig. 2 is a sectional view showing the construction.

It consists substantially of two parts, a body having a ½-inch shank, and a cross slide accurately fitted and gibbed thereto. This cross slide is provided with a ¼-inch draw-in chuck for holding boring tools and has a travel of 3/8 inch which makes it possible to enlarge a hole ¾ inch without change of tool. The lateral position of the slide is controlled by a micrometer screw, the dial of which is graduated to read to thousandths.

The tool can be used on any milling machine having a suitable chuck for handling it.

Exhibits at the Automobile Show

The Tenth International Automobile Show of the American Motor Car Manufacturers' Association was held in Grand Central Palace, New York, December 31 to January 7. This was the most successful show that has so far been held, and applications for floor space were much greater than that available, and consequently many were not able to show their product. Many new things were exhibited, but the most striking feature of the show was the entire absence of the high-wheel or buggybout type of automobile. This is doubtless due to the fact that the high-wheel car does not take well in the East owing to the road conditions, appearances, or other things. It has, however, a large sale in the West where the public have got used to its looks, and no doubt there is a good future for this style of car.

The wind shield has come into popular favor and was exhibited on a large number of the cars. Many of the manufacturers are supplying this with their regular equipment. Several of the cars are placing their steering wheel on the left-hand side, which makes it easier for the driver and passenger on the front seat to alight on the sidewalk. For this reason it promises to become the popular style. The mud guards have almost universally been changed to the solid design that runs from the front to the rear of the car and includes a step between the wheels. Wheels are getting larger, 34- and 36-inch wheels being used in place of the 28-inch wheel that was once the leading size.

Among the 325 exhibitors were 72 exhibitors of leading American cars that ranged in price from the McIntyre at $475 and the Brush at $485 to the $6000 and $6500 cars of the Acme, Austin, Welch and Chadwick models; 12 exhibitors of foreign cars, some of which were $10,000, and 17 exhibits of commercial vehicles. Among the new cars exhibited were the sample car that has just been turned out by the Otto Gas Engine Company, who are starting to manufacture automobiles, and the Everett car of Detroit. This car is made by the company formed by Messrs. Everett and Metzger, whose interest in the Everett-Metzger-Flanders Company was bought out by the Studebaker Company. This car has the upper half of the crank case and the four cylinders, together with the exhaust and intake manifolds cast in one piece, while the Otto car has many new features in its design, but has the same general appearance as other high-grade cars.

The Bartholomew Company of Peoria, Ill., have overcome the troubles met with in the worm and sector steering gear by a new design of steering gear that uses a bevel gear and pinion and imparts the motion to the steering arm through a link that makes the gear irreversible; thus the most delicate touch of the steering wheel brings a quick response and it is always locked against movement when either of the front wheels strikes an obstruction.

Among the new motor-car accessories that attracted the most attention was the Jones live map. These maps are laid out on disks about 8½ inches in diameter, with the full direction as to what road to take and each map covers one hundred miles. They are connected to the front wheel by a flexible shaft, the same as a speedometer, and as the car travels along the road the map revolves and the pointer on it indicates where one is and the road to take.

The Cotta transmission is growing in favor owing to the fact that the gears are always in mesh and the clashing is done with dog clutches that grip around the entire rim.

That the automobile truck is growing in use and is fast becoming a prominent industrial fixture, was shown by the fact that more space was used for exhibiting trucks than at any former show. The different manufacturers had exhibits of trucks in several different styles, one of which was a pay-as-you-enter stage similar to the street cars. Several cars were shown on the outside of the building, owing to the fact that they could not secure space inside.

Many improvements are being made along this line and one of the most notable of these is shown in the Sultan taxi

FIG. 2. SMALL SIZE OF LANSDEN ELECTRIC SHOP TRUCK

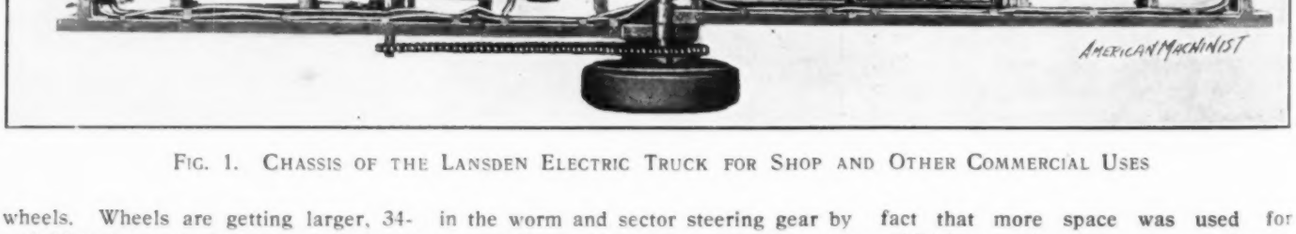


FIG. 1. CHASSIS OF THE LANSDEN ELECTRIC TRUCK FOR SHOP AND OTHER COMMERCIAL USES

cab and truck. In this the power unit is removable after taking out six bolts. Thus, it is possible to have an extra power plant to put in when another is taken out to be repaired. As, for instance, if one is running a taxicab business he can keep ten cabs running by using eleven power plants, one of which would be in the repair shop while the others were working.

Another feature was shown in the Carlson truck, in which, by removing six bolts, the upper part of the crank case could be lifted off and with it came the cam shaft. The engine being two cylinder opposed, this left all the different parts of the engine easily accessible for renewing or repairing. In practically all the trucks it has been the object to so design them that different units could be taken out for repairs by the removal of a few bolts.

The Lansden Company, Newark, N. J., exhibited an electric truck that is very useful in transporting work up and down the gangways in a shop, and around the yards or other places. The truck is built in two sizes, the chassis of the larger size being shown in Fig. 1 and the truck of the smaller size in Fig. 2. As will be seen the larger size is four wheeled, but the front and rear wheels are placed in the center of the truck and connected by sprockets and chains, so that in steering both wheels move simultaneously. By this method it is possible to turn the truck within its own length. Both of these trucks are four feet wide and have a load capacity of 4000 pounds, with a speed of four and one-half miles an hour and Edison batteries that will hold charge enough to run them eighteen miles. From the floor to the platform of the car is twenty-eight inches. The larger truck in 14 feet 6 inches long and hinged in the center so as to fit any inequalities in the floor or road over which it is traveling. It can be steered from either end, the steering wheel being merely pulled out of the socket at one end and placed in a similar socket at the other end. The shorter car is ten feet long.

Among the accessories exhibitors were many foundries showing iron and steel castings as well as aluminum castings and those of other non-ferrous metals. Among these the Vanadium Metal Company, which is making vanadium bronze castings, exhibited a new nickel alloy that is non-corrosive.

The Doehler Die Casting Company exhibited the best line of samples of this kind of work that has been shown, among them being many large and complicated pieces. This firm has made a big improvement in the methods and metals used for casting in dies under pressure and consequently much better results are obtained as to strength.

Many firms exhibited samples of their forged, fusion and electric welded, pressed, stamped and bent metals and several steel firms were there with their vanadium, nickel, nickel-chrome and other high-grade steels used in automobile construction. One high-speed steel was shown, namely, "Poldi," which is made in Austria.

The Art of Getting a Job

By L. S. Le Tellier

There is a time in the experience of every man when jobs do not come seeking him. All of us recall a day in our lives when we stood timidly before some "boss," and meekly asked that high and mighty man to give us a job. It may not be known to us, but many and many a time these job seekers have failed for no better reason than the fact that they did not go after the job in the right way. I have been in the office of a "boss" scores of times and seen men absolutely fail because of the foolish, artless way in which they approached the would-be employer. There is an art in getting a job, just as there is an art in selling goods. The fact that you have been turned down is frequently not because there is nothing to be done, but because you have succeeded in a few moments of conversation with the employer to impress him with the fact that you are not the man for the job.

I have seen men who may have been competent mechanics behave like embarrassed children when asking for a job. I have seen them stammer and stutter as if tongue-tied, and behave in various and sundry ways well calculated to impress the employer that they were half-witted. Then again, there are the so-called "Smart Alecks," glib of tongue, saucy and offensive in manner, but entirely lacking in that keen sense of the fitness of things which tells a person that the main thing in approaching an employer is to impress him with the fact that you are willing and qualified to do the work which you seek.

The author in the course of his experience as an office man constantly in the presence of the superintendent of a big industry has observed the behavior of a large number of men seeking jobs, and in the course of that experience he can count on the fingers of a single hand the men who could be called A-1 men at getting jobs. He has in mind the experiences of three men who were masters of the art, not because of any protracted experience but because they were men possessing a keen knowledge of the proper method of approaching men and of holding their own in the face of defeat. The three incidents which are to be here narrated are fine examples of how a resourceful man may turn victory into defeat as well as useful information to men who are anxious to know something about the "technic" of landing a job. In each case these men were told in the beginning that there was nothing that could be given them to do and in each case they were undismayed at what is usually accepted as a failure. They could have quietly walked out of the office and been no bigger failure than thousands of their fellows who give up without a struggle. In each of these incidents these men got jobs where many had been turned down before them, and in addition to this in two cases of the three there was really no vacancy or need for a man. In each case the men succeeded because of an ability to size up the boss and impress him with the fact that he was in the presence of a live, active, resourceful man.

John Smith (we will call him) was a young man twenty-four years of age, a skilled draftsman, ready, willing, pulsating with energy, resourceful, and possessing to a marked degree that valuable quality of knowing what to do when everybody else is at a loss to determine the next move. The shop in which John was working closed down during the business depression, and he was without a job. Packing his tools without delay he boarded the train for a neighboring city, facing the proposition of getting a job.

When admitted to the presence of the superintendent he stated in a calm, matter-of-fact, but confident manner that he was a draftsman of experience and ability and wanted to work for the superintendent's firm.

"Nothing to do," was the firm reply from the desk, and the busy man continued his work. John Smith evidently viewed the situation in this wise: To walk out without another word meant that he had absolutely failed to accomplish what he was determined to do, to go after the boss at a different angle *might do* some good, and certainly no harm. Herein he was unlike hundreds of his fellow workmen, and the boss saw it at once.

"But," was the determined reply, "when will you need a draftsman?"

"Can't say," was the laconic reply, "Good day, sir." This seemed absolutely final, but John was still game.

"I am sorry to disturb you, sir, but I am compelled to go to work, and I want to work right here.

"We don't need anybody, and you can't get anything to do here," was the impatient reply of the superintendent as he waved his hand in a gesture of dismissal.

"But," insisted John, "I am out of work. I won't loaf, and why can't I go in and work a week to pass away the time? You don't have to pay me." His voice was low pitched, his manner quiet and determined. There was something in his bearing which said plainly that he had come into that office to get a job and he was determined to push his way in. The superintendent leaned back in his chair, hesitating between exasperation and admiration for the man still insisting after being twice dismissed. From my desk in the corner of the office I watched this encounter between a determined young man and a surprised boss.

"I had rather be in the office working than loafing; and, too, you might find me a valuable man. May I work a week as an application for the first vacancy?" continued John.

The superintendent looked over the boy from head to foot several times. This was a new proposition, and he was doing much thinking in a few seconds. His expression changed from one of impatience to one of surprise. The boy, perceiving that the boss was at least for a moment at a loss, at once followed up his request:

"I am in earnest about this, and I would like to have your permission to report in the drawing office. At the end of a week I will leave and won't ask for pay."

The boss at once recognized in this young man a kind of quiet tenacity which would be worth something to his company. The young man's proposition was so fair, so original, and so expressive of determination that the boss yielded.

"Very well, sir, if you care to try it in this way you have my permission but no promise," was his somewhat indifferent reply, but a month later John Smith was in the drawing office, and the boss had both eyes on what seemed to be a man far above the common level of his kind.

John Jones was a young man about twenty years of age and just out of college. He was youthful in appearance, small in stature, and taken all in all there was nothing in his appearance to mark him as a man of anything out of the ordinary run of humanity. He had graduated in mechanical engineering, and was now ready to approach that vast, undiscovered place which commencement orators speak of as the "world." As is the custom with the young graduate he had unbounded confidence in his ability to make good; but, withal, he was level headed enough to turn this confidence into an asset rather than means of making a fool of himself.

John Jones was ushered into the office of the engineer-in-charge of the drawing rooms. Many an aspiring college man had gone before him to be withered by the sarcasm of this able but irritable engineer. On this particular occasion he was in an uglier mood than usual, and the youthful John happened along just in time to be the target of his sarcasm.

"What the devil do you want to do?" was his reply to John's statement that he was a college graduate in mechanical engineering and wanted to locate. The contempt in which some experienced men hold these young college graduates was flung in the face of John Jones, but he was equal to the best. To win in a contest with this hot-tempered engineer meant that you must match your wit against his and drive him to fury or sober him by your own nerve. John Jones took chances and won.

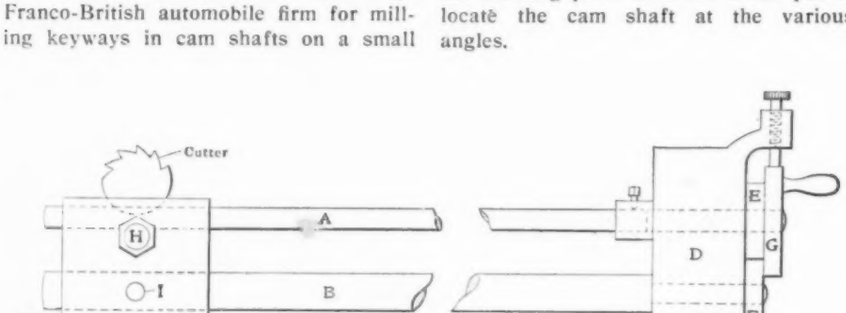
"I want to be general manager of these shops, but I suppose somebody else has that job, so I'll take the next best," was the quick and somewhat disconcerting reply. The fact that the youthful John had not beat a hasty retreat when first growled at had convinced the boss that he had nerve, but when this witty, ready reply piped forth from him the sarcastic one was man enough to acknowledge defeat.

"You are saucy as h——, but I am going to give you a chance," were the words of his capitulation; and the ready witted John, who could look any man in the eye and talk straight at him, was given a job as detailer. Today that same boss swears by this young assistant of his who made good at every point.

Milling Keyways in Cam Shafts

By R. L. Grove

The rig shown was in use by a large Franco-British automobile firm for milling keyways in cam shafts on a small Pratt & Whitney milling machine. When properly set, it accurately milled and spaced at the proper angles all the cam shafts used by that firm and turned out the job rapidly.



Milling Keyways in Automobile Camshafts

A is the cam shaft made of bright drawn or rolled rod. It is chucked in the sliding dividing head *D*, which slides in the slot in the machine table. *B* is the spacing bar with spacing holes set at the required distances; these are located by the pin *I* in the head *C*.

E and *F* are two equal gears and *G* is the dividing plate with the usual pin to locate the cam shaft at the various angles.

C is fixed to the table of the machine and is bored to receive both the cam shaft *A* and the space bar *B*.

After the cam shaft is chucked the bearing *C* is tightened by the cap screw *H*, the locating pin *I* having first been put in *B*. The keyway is then cut. The next keyway requires the locating pin *I* to be taken out, *H* to be slackened and the dividing plate *G* moved to the next division. Then *D* is slid along to the next hole in *B*, the pin *I* is replaced and the next keyway cut; and so on until all the keyways are cut.

Coal Gas Poisons

Experiments on dogs to determine the poisonous properties of illuminating and coal gas, according to the *Ironmonger*, showed that the poisonous effect of coal gas was twice or three times as great as that of the carbonic oxide it contained. Evidently there is some other constituent of coal gas which is poisonous, though what it is cannot yet be stated. Merely removing the carbonic oxide from coal gas will not suffice to render it non-poisonous. These experiments show results contrary to the generally accepted theory that the poisonous properties of coal gas are due to its content of carbonic oxide. From farther experiments made by Doctor von Vahlen, at Halle, with frogs, animals particularly resistant to carbonic oxide, it was found that they were poisoned far more rapidly by coal gas than by the corresponding amount of the oxide.

INCREASING · SHOP · CAPACITIES

where More Tools will be needed

The Glenco (Minn.) Roller Mill was destroyed by fire.

W. H. Dunwoody, Minneapolis, Minn., will erect a $10,000 garage.

The electric light and water plant at Bellevue, Iowa, was burned.

The White Furniture Company, Allegheny, Penn., is erecting a new factory.

The Manhattan Oil Company will build a new boiler house at Omaha, Neb.

The South Amboy (N. J.) Lumber Company is planning extensions to its plant.

F. P. Kirkendall will erect an eight- or ten-story shoe factory at Omaha, Neb.

The Belknap Company, Richfield, Utah, is preparing plans for a new power plant.

John Hoberg Company, Green Bay, Wis., will erect an addition to its paper mill.

The Flour City Ornamental Iron Works, Minneapolis, Minn., will erect an addition.

The Moore-Faherty Piano Company, St. Louis, Mo., will erect a new $50,000 factory.

The Reinforced Tile Roofing Company, Youngstown, Ohio, will build a new factory.

The New York Central Railroad will build car shops at Oswego, N. Y., to cost $150,000.

Fire caused $20,000 damage at the plant of the Woonsocket (R. I.) Shuttle Company.

The Bemis Brothers Bag Company, St. Louis, Mo., has bought site for an additional factory.

The Muncie (Ind.) Chair Company, a new concern, will require woodworking machinery.

The elevator of the Central Granaries, Rockford, Neb., was burned. Will be rebuilt.

The Remington Machine Company, Wilmington, Del., will require some new equipment.

The Ontario Iron and Steel Company, Welland, Ont., will build an extension to its plant.

The Goliad (Tex.) Irrigating Machinery Company has commenced work on a new plant.

The White Enamel Refrigerator Company, St. Paul, Minn., will build a two-story addition.

The Kokomo (Ind.) Motorcycle Company, recently organized, is preparing to erect a factory.

The Franz Meyer Piano Company, Oak Park, Ill., is having plans prepared for a new factory.

The Keller-Dunham Piano Company, Scranton, Penn., will erect a new three-story factory.

Hupp, James & Halloran, Detroit, Mich., have let contract for the erection of a foundry building.

The Guarantee Hosiery Mills, at Des Moines, Iowa, was burned. Loss, about $50,000.

Fire at the plant of the American Bridge Company, Milwaukee, Wis., caused a loss of $250,000.

The Pittsburg and Lake Erie Railroad will install a steam turbine in its power station at Pittsburg.

The planing mill of the Covington (Ohio) Lumber Company was destroyed by fire. Loss, about $30,000.

The tub and box factory of Nelson & Hall, Montgomery Center, Vt., was burned. Loss, about $75,000.

Fire destroyed the plant of the Conneaut (Ohio) Shovel Company, causing a loss of about $50,000.

The planing mill of the Stark Lumber Company, Canton, Ohio, was burned. Loss, about $10,000.

It is said the Santa Fe Railroad may build a roundhouse and machine shops at Galveston, Texas.

The plant of the National Elevator Company, at Langdon, N. D., was burned. It will be rebuilt.

The Edward Maher Sons' Iron Foundry, Newark, N. J., is having plans prepared for a new foundry.

The Canadian Iron Corporation, Fort William, Ont., is preparing plans for an addition to cost $50,000.

H. M. Seivert, of Shawano, Wis., is making arrangements to establish a woodware plant in Portland, Ore.

The Atwood Brass Works, Grand Rapids, Mich., will probably build an addition to its plant this spring.

The roundhouse of the Rutland (Vt.) Railroad at Alburg, was destroyed by fire, causing a loss of $100,000.

The Clinton (Iowa) Gas, Light and Coke Company contemplates increasing the capacity of its power plant.

The factory of the National Adjustable Chair Company, Greenfield, Ind., recently burned, will be rebuilt.

The Pennsylvania Metallic Tubing Company, Philadelphia, Penn., has purchased a factory building and ground.

W. Ames, 312 Washington street, Jersey City, N. J., is erecting a plant for the manufacture of spikes and bolts.

The power station of the Boston (Mass.) Elevated Railroad, on Harrison avenue, was burned. Loss, over $40,000.

The Kilborn & Bishop Company, New Haven, Conn., making drop forgings, will erect an addition to its plant.

The Cleveland (Ohio) Tool Steel Company is to build a new plant in the spring, doubling its present capacity.

Fire recently damaged the plant of the Canadian Iron Foundry Company at Montreal to the extent of $70,000.

It is announced the Union Pacific Railroad will build a $400,000 roundhouse and shops at Evanston, Wyo., in the spring.

Fire destroyed the hammer and furnace house of the Titusville (Penn.) Forge Company, causing a loss of about $50,000.

The Iroquois Iron Company will build two new furnaces at its plant in South Chicago, Ill., with a daily capacity of 700 tons.

The Ashland Cotton Company, Jewett City, Conn., is erecting an addition to its mill and in the spring will erect another addition.

Plans are being prepared for the proposed plant of the Seekonk Lace Company, Pawtucket, R. I. Henry J. Lynd is president.

The Connecticut Keys Process Company, Montville, Conn., is making changes in its paper mill. Will need some machinery.

The R. L. Kenyon Company, La Crosse, Wis., will erect a plant at Waukesha, Wis., for the manufacture of motor boats, etc.

The E. L. Shuford Manufacturing Company, Lawton, Okla., has awarded contract for the erection of a $100,000 cotton mill.

The Bongartz Company, of New York, manufacturing automobile accessories, has purchased site in Lincoln, N. J., for a new plant.

The Midland Water, Light and Ice Company, Dodge City, Kan., will need new power equipment, including engine, boiler, generator, etc.

The Cates Machine and Bridge Company, Burlington, N. C., recently formed, will establish a plant for the manufacture of structural parts.

John Bromley & Sons Company, Philadelphia, Penn., making rugs and curtains, will build a new factory at a cost of about $50,000.

Ernest and Herman Levy, of 72-78 Greene street, New York, manufacturers of silk ribbons, have bought site in the Bronx for a new factory.

The Cambria Steel Company, Johnstown, Penn., has commenced work on the new wire and rod mill to be erected near Sheridan Station.

Henry Doherty, Paterson, N. J., is erecting a silk mill at Lakeview, N. J., which, it is said, will be the largest plant here under one roof.

The Crescent Fixture Company, of Grand Rapids, Mich., will establish a factory in Grandville for the manufacture of wooden specialties.

The Universal Motor Company, Denver, Colo., has plans for an automobile factory which, it is said, will be one of the largest in the country.

The Washington County Light and Power Company, Stillwater, Minn., has increased its capital stock to $1,000,000 and will increase its facilities.

Chas. A. Stickney Company, of St. Paul, Minn., manufacturing gasolene engines, will erect a plant at Niagara Falls, Ont., to cost about $75,000.

The Northern Engineering Works, Detroit, Mich., has purchased more land on which an addition to its cream plant will probably be built this season.

The American Locomotive Company is preparing plans for the extension of its automobile plant in Providence, R. I. About a million dollars will be expended.

The Williman Manufacturing Company, Houston, Texas, recently organized, will erect a factory for the manufacture of wooden crates. Anton Williman is president.

The Davenport (Iowa) Locomotive Works is to spend $250,000 in improvements to its plant this spring. New pattern, blacksmith, machine and repair shops are to be erected.

The Niles (Ohio) Car and Manufacturing Company has increased its capital and changed its name to the Blue Island Rolling Mills. A large rolling mill will be built at Blue Island.

The Keller Manufacturing Company, Sauk Center, Minn., has purchased site in St. Paul, Minn., on which a $75,000 plant will be erected for the manufacture of wagons and farm implements.

New Incorporations

Mathewson-Marr Aëroplane Company, Denver, Colo. Manufacture airships. Capital, $25,000. E. Lynn Mathewson, president.

Hubbard Steel Foundry Company, Chicago, Ill. Iron and steel products. Capital, $250,000. Incorporators, J. P. Grier, W. H. Tuttle, N. D. Cross.

S. W. Childs & Co., Incorporated, New York. Automobile garage, automobile supplies, etc. Capital, $25,000. Incorporators, S. W. Childs, M. H. Childs, W. G. Whaley.

William Manufacturing Company, Houston, Tex. Manufacture wooden crates. Capital, $300,000. Incorporators, Anton William, Frank L. William, F. E. Pye, etc.

River Engineering Company, Hartford, Conn. Manufacture machinery, dies, gages, etc. Capital, $10,000. Incorporators, Wm. M. Clary, C. E. Thorngran, Thos. J. O'Brien.

General Ball Bearing Company, Camden, N. J. Manufacture ball and roller bearings. Capital, $500,000. Incorporators, J. A. MacPeak, W. F. Eidell, F. R. Hansell.

Chicago Central Manufacturing Company, Chicago, Ill. Valves and metallic appliances. Capital, $20,000. Incorporators, J. S. Hummer, Chas. A. McDonald, J. P. Dunne.

Rochester Drop Forge Company, Rochester, N. Y. Manufacture machinery, tools, etc. Capital, $40,000. Incorporators, L. M. Beattie, L. W. Hostettler, F. K. Thompson.

Asbury Park Automobile Company, Asbury Park, N. J. Manufacture automobiles. Capital, $50,000. Incorporators, D. Havens, F. T. Weeden, W. C. Weeden, L. P. Croce.

Whistler Manufacturing Company, Port Huron, Mich. Manufacture magnetos, etc. Capital, $100,000. Incorporators, Ralph H. Whistler, W. B. Robinson, W. L. Baker, of Detroit.

Business Items

The Skinner Chuck Company, New Britain, Conn., gave a banquet to its employees at the New Britain Club, December 28, 1909.

The Hess-Bright Manufacturing Company, Philadelphia, Penn., has gotten out a convenient and accurate slide rule, which it is sending gratis to engineers and others in charge of machine-making plants.

Trade Catalogs

Oneida Steel Pulley Company, Oneida, N. Y. Catalog describing steel and wood pulleys. Illustrated, 48 pages, 6x9 inches, paper.

H. W. Johns-Manville Company, 100 William street, New York. Bulletin No. 2, describing linolite system of electric illumination. Illustrated, 8 pages, 6x9 inches.

Sargent Steam Meter Company, 271 East Madison street, Chicago, Ill. Catalog describing Sargent automatic gas calorimeter and accessories. Illustrated, 32 pages, 3½x6 inches, paper.

Forthcoming Meetings

American Foundrymen's Association and American Brass Founders Association; joint convention, June 7-8-9, Detroit, Mich.; headquarters, Hotel Pontchartrain. Richard Moldenke, secretary, Watchung, N. J.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper catalog free. E.G. Smith, Columbia, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Machines designed; automatic special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Drawings for automatic and special machines made; designing pumps, attention given. Address "Mechanical," Box 1, AM. MA.

We design or build light and medium weight machinery, dies, tools, jigs, fixtures and model work. Matson Machine Co., Bethel, Vt.

Home work wanted: machine design, automatic, special; practical working drawings, tracings; reasonable rate. F. L. Marquardt, 921 Broadway, Brooklyn, N. Y.

Machinery to manufacture on contract; designers, patternmakers and founders; we can handle work from very light up to 15 tons. Hydrostatic Machinery Co., Rochester, N. Y.

Wanted—Purchaser for No. 2 Farwell milling machine. Grant hobbing machine and Gisholt tool grinder; all practically new and in A-1 condition. Box 755, AMER. MACHINIST.

Curtis & Driver, Buffalo, N. Y. Mechanical draftsmen; automatic and special machines, tools, jigs and fixtures of all kinds designed, typewriters, adding machines and automobiles.

Wanted—Machine work for lathes, shapers, milling machines, screw machines, etc., and would be pleased to figure on your dies, jigs, models, sheet metal stampings and auto parts. The F. G. Marbach Co., Medina, Ohio.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

An old established English firm is prepared to take out and purchase really good sound inventions for Europe, or will make and sell on royalty; bankers' reference given. Fastnut, Ltd., 60, Aldermanbury, London, Eng.

Wanted—First-class hand screw machine foreman; job also includes two Brown & Sharpe and one large sized Gridley automatic; man must be resourceful and first-class handler of help; good pay to the right party. Box 79, AMERICAN MACHINIST.

Wanted—Either new or second hand in A-1 condition; One power cross feed engine lathe with compound rest, with or without taper attachment and chucks, 18" to 24" swing by 8' to 10' bed; one drill press 22" swing, back geared, with or without attachments; one 15" pillow shaper; one power hack saw. Dickinson & Co., Eureka, Ill.

THE ANNUAL MEETING of the stockholders of the Hill Publishing Company, for the election of directors for the ensuing year and for the transaction of such other business as may properly come before the meeting, will be held at the office of the company, in the Hallenbeck Building, 497-505 Pearl St., Borough of Manhattan, New York City, N. Y., on Tuesday, January 25, 1910, at 12 o'clock noon. Dated, New York City, December 6, 1909. Robert McKean, Secretary.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Tool room foreman and mechanical expert desires change; capable of handling large propositions, organizing and producing systematically tool work in all its branches, special appliances and devices for modern interchangeable manufacture. Box 61, AM. MA.

DELAWARE

Wanted—Position as draftsman; have a good experience as a mechanic. Box 68, AMERICAN MACHINIST.

IOWA

Wanted—Successful foundry foreman desires to make a change; would be glad to correspond with any one in need of first-class man, who has had practical experience as foreman and molder, is familiar with every detail connected with the economical operation of a foundry; references furnished. Box 60, AMERICAN MACHINIST.

MASSACHUSETTS

Engineer and designer, 38; experienced on mill construction, power transmission, machinery, power, pumping plant, hydraulic elevator layouts and estimating. Box 75, AM. M.

Responsible position by practical mechanic with theoretical knowledge; wide office and factory experience; designer of special machinery and tools; factory superintendent, etc. Box 49, AMERICAN MACHINIST.

MICHIGAN

Shop superintendent or foreman; practical mechanic and executive in machine building, cost reducing and up-to-date methods of manufacturing interchangeable parts; 20 years' experience; best of references. Box 17, AM. M.

Mechanical draftsman and designer wishes to locate with company manufacturing pumps and compressors as assistant superintendent, or in sales department; can specify sizes and types for installation in both steam and power driven; at present employed. Box 72, AMERICAN MACHINIST.

NEW YORK

Position as head of production department by young man with high school and business education and ten years' experience; best of references. Box 57, AMERICAN MACHINIST.

An A-1 toolmaker and machinist, with good executive ability, well up in tool design, desires an executive position; can produce results economically; similarly employed at present; references. Box 58, AMER. MACH.

Technical graduate desires position as assistant superintendent, assistant engineer or chief draftsman, with concern offering best opportunities for advancement; is now employed; eastern States preferred. Box 74, AMERICAN MACHINIST.

Draftsman, designer, toolmaker and general mechanic, desires position either as foreman or draftsman capable of developing special machinery and experimental work; inventive ability; open for engagement February 1. Box 59, AMERICAN MACHINIST.

Experienced superintendent, now employed, open for engagement; large experience in manufacturing small or medium interchangeable work; good reliable mechanic with executive ability; thorough experience in modern shop methods. Box 77, AMER. MACH.

Man thoroughly experienced and up to date in modern machine shop methods, familiar with use of high speed steels, desires change; position of superintendent, general foreman, or head department foreman; have good record for past six years as head department foreman; who wants me? I can produce the goods; automobile shop preferred. Address Box 73, AMERICAN MACHINIST.

OHIO

Designer and draftsman, college graduate, with shop experience, wants to change; any locality. Box 78, AMERICAN MACHINIST.

Superintendent, now employed, desires a change; gasolene engines, steam pumps, special machinery, tool building; a hustler with an earning power; go anywhere. Box 76, AMERICAN MACHINIST.

Machine tool designer, technical graduate, seven years' experience in machine tools, special automatic machinery, tools, jigs and fixtures for light, high grade machinery, wishes to make a change. Address Box 54, AM. MA.

PENNSYLVANIA

Wanted—Position as foreman or superintendent of pattern and woodworking department, by an experienced, up to date man of character. Box 65, AMERICAN MACHINIST.

Designer, graduate, 12 years' experience, special, automatic, fine machinery, typewriters, experimental work; age 32; very capable on practical development, new designs for responsible position. Box 44, AMER. MACH.

Works manager or superintendent desires position with large responsibilities; thoroughly competent and experienced in the interchangeable system of tool and machinery manufacturing; over 12 years' executive experience; best of references. Box 53, AM. M.

WISCONSIN

Experienced mechanical engineer wishes position as manager of branch office or commercial engineer with firm manufacturing gas engines and gas producers. Address "Optimus," AMERICAN MACHINIST.

TOOLS and METHODS USED in MAKING STAR LATHES

Accuracy and Economy Are the Essential Features

EDITORIAL CORRESPONDENCE

The building of engine lathes in large quantities gives opportunities for the introduction of many special methods and devices, and the tools illustrated herewith show that the Seneca Falls Manufacturing Company, Seneca Falls, N. Y., has taken advantage of these opportunities in many interesting ways in making its "Star" lathes. Although the name still lingers in the memory of the older mechanics in connection with machines for amateurs, the methods illustrated herewith will clearly indicate that the present product is entirely free from this designation and that the lathe now turned out belongs in the list of regular machine tools.

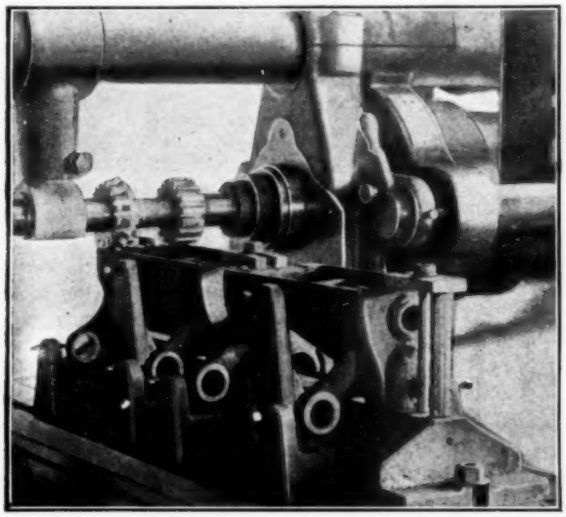


FIG. 1. MILLING HEADSTOCK FOR THE BEARING CAPS

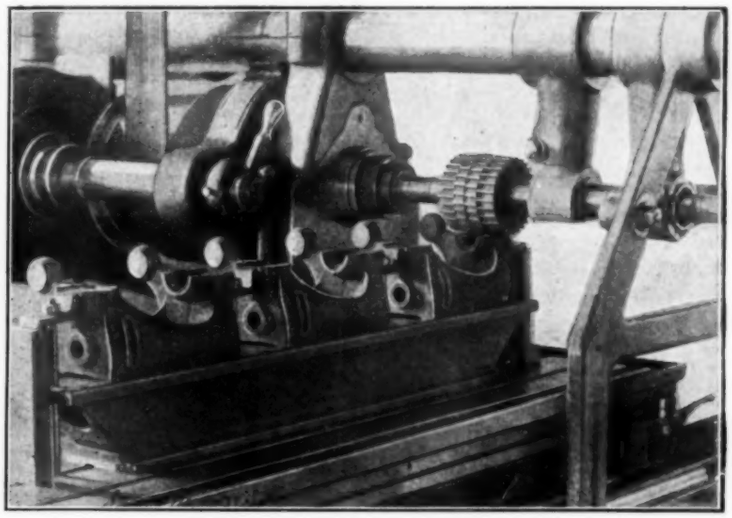


FIG. 2. MILLING THE BOTTOM OF THE HEADSTOCK

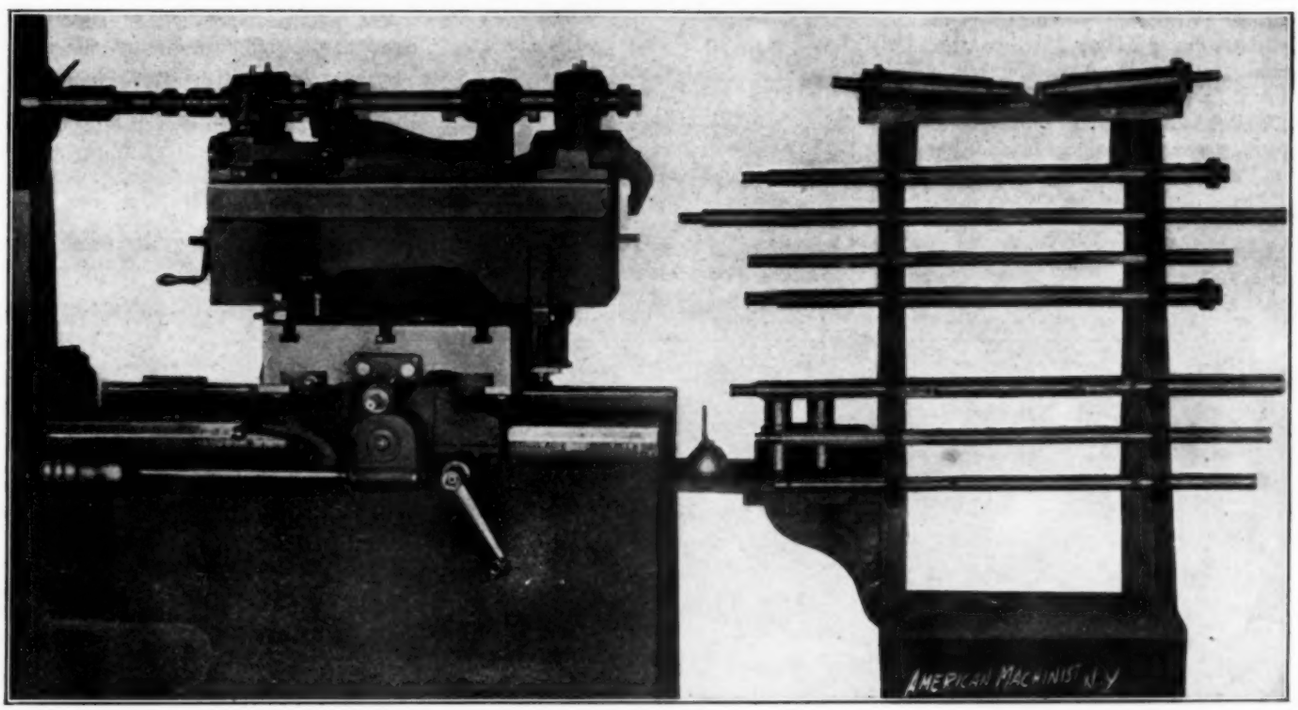


FIG. 3. BORING FIXTURE FOR HEADSTOCK AND TAILSTOCK

MILLING THE HEADSTOCKS

Beginning with the headstock, it will be noticed that milling is used, instead of planing in a large majority of the surfacing operations, Fig. 2 showing a pair of cutters for forming the flat and the V which rests on the bed. The casting being milled rests on hardened steel points which extend above the top of the fixture to insure clean locating points, and it will be noticed that the top is sloped on both sides so as to shed the

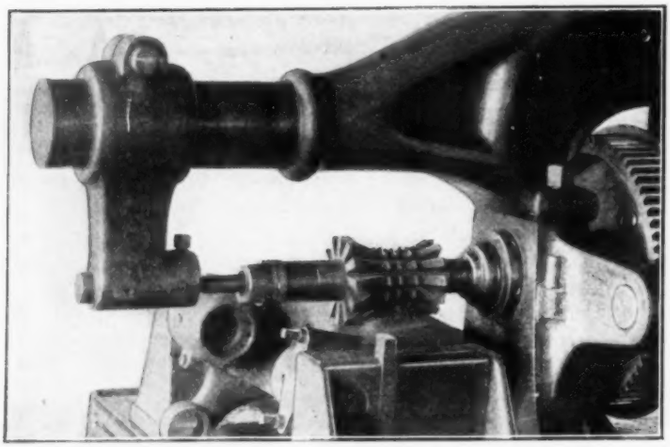


FIG. 4. MILLING REVERSE NOTCHES IN HEADSTOCK

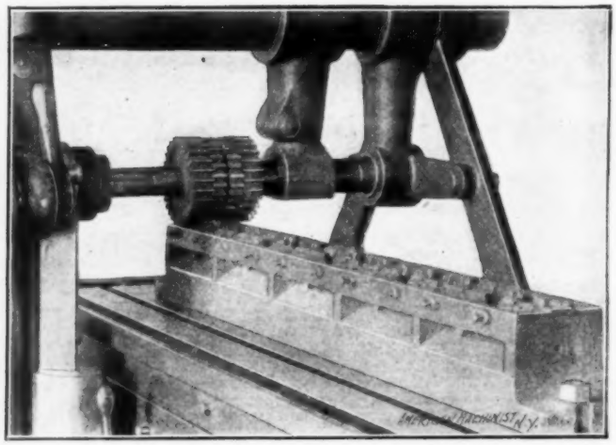


FIG. 5. MILLING HEADSTOCK CAPS

chips. These fixtures are substantial in every way and prevent springing under the cut.

The headstocks are then turned over on a lathe-bed mounting on the milling machine that mills them for the caps which cover the bearing, as shown in Fig. 1.

BORING FOR SPINDLES

The next operation is boring for the spindle, back gear and feed-stud bearing. This is done on a Lucas boring machine, as shown in Fig. 3, the head being mounted in a special fixture clamped to the table. The headstocks are first scraped to the ways of a master plate and are held on this fixture in the same manner and in the same position as they are on the lathe bed. The holes for the spindle bearing are roughed and then finished by bars containing two cutters each. They are then reamed within 0.002 inch outside diameter by two roughing reamers and one bar operated by power, and then a hand finishing reamer is used to bring them to size. This reamer is guided by long, hard-steel bushings.

The facing bar shown, containing four cutters set at proper distances, machines the inside and outside ends of both bearings, the distance between the bearings being determined by hardened stop collars on this bar. Two sets of cutters are used. The headstock is located lengthwise by a stop which fits the slot for the reverse yoke lever.

FIG. 6. A CONVENIENT SCRAPING STAND

Oil grooves are cut at the ends of the bearings by a bar with four boring tools which are fed outward simultaneously and automatically by an endwise movement of the boring-bar spindle. The depth of this cut is governed by a stop and the cutters are returned to their normal position by moving the boring-machine spindle in the opposite direction. The bearings for back gears and the feed stud are machined in a similar manner, all boring bars, reamers and similar tools being guided by hard-steel bushings.

The tailstocks are also bored on this same fixture and in a similar manner to the headstocks already described, and are, therefore, in correct alinement with the headstocks when placed on the lathe bed. Before boring the tailstocks the upper and lower parts are carefully scraped to the master plate, and when clamped to the boring fixture are in the same relative position as when in use on the lathe.

A convenient rack for holding the vari-

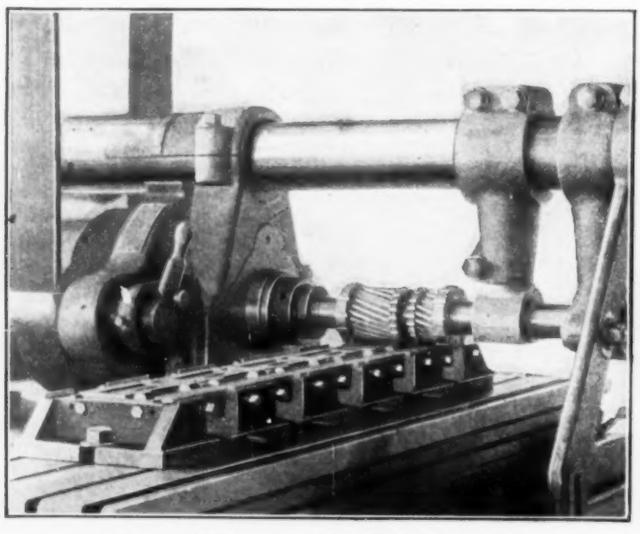


FIG. 7. MILLING BOTTOMS OF TAILSTOCKS

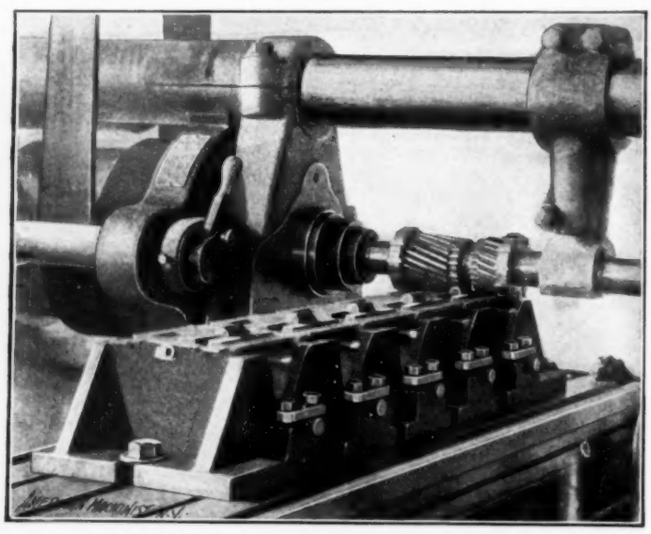


FIG. 8. MILLING THE TAILSTOCKS FOR BOTTOMS

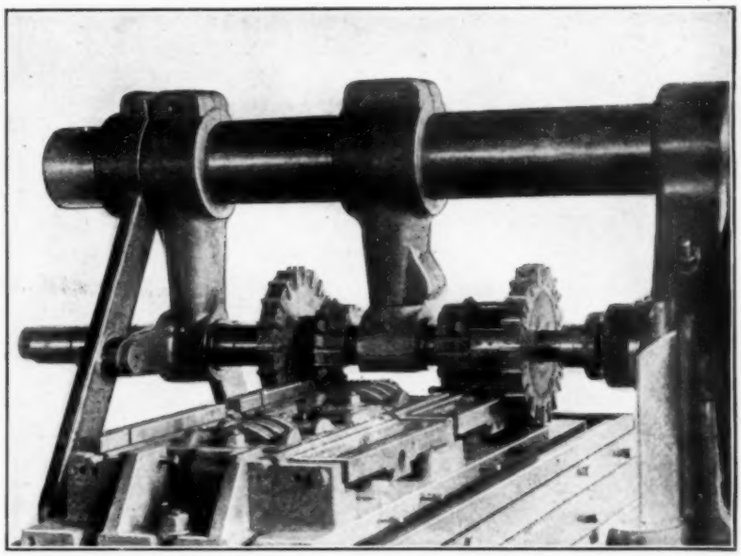


FIG. 9. MILLING UNDERSIDE OF CARRIAGES

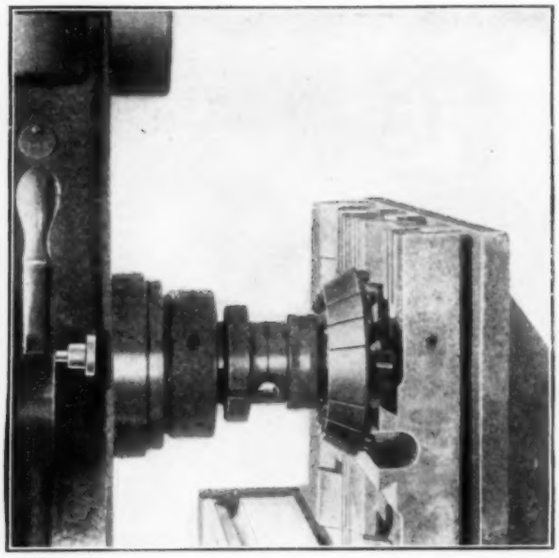


FIG. 10. MILLING WAYS FOR CROSS-SLIDES

ous boring tools used in this work is shown at the right of the machine.

MORE MILLING OPERATIONS

Returning to the milling machine, we have in Fig. 4 the method of milling notches in the headstock for the reverse-feed lever knob. The headstock is located in the fixture on hardened steel plugs in the spindle bearing and also in the hole for the feed stud, after all holes have been finished. This fixture also acts as a gage for testing the location of the holes for the feed stud in relation to the spindle bearing. The gage shown on the front of the fixture is used for setting the high-speed steel formed cutter, both as to its location lengthwise and the depth of the cut.

In the meantime the caps for the headstock bearing have been milled in the gang fixture holding 10 caps, as shown in Fig. 5. These are held in the fixture

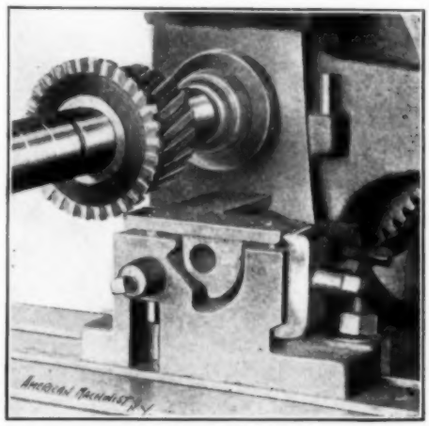


FIG. 11. MILLING FIXTURE FOR WORM BRACKETS

by means of knife-edge expansion wedges which hold the caps lengthwise against the stop and draw them down firmly. The fixture frees itself of the chips by means of the opening on both sides and the inclined surfaces.

In Fig. 6 is a very convenient adjustable scraping stand as can readily be seen. This is easily adjustable both for hight so as to be convenient for the operator and can also be swiveled around the horizontal trunnion if desired. The pieces being scraped are clamped in such a way as to be free from strain which would have a distorting effect.

TAILSTOCKS

Tailstocks are handled in a similar way, Fig. 7 showing the fixture and the gang of cutters used in milling the top of five tailstock bottom pieces. Fig. 8 shows the milling of the bottom of the tailstock to match the bottom, each tailstock being located by a standard arbor through the spindle hole, the arbor being clamped in the V-block, shown.

THE CARRIAGES

Fig. 9 shows the fixture used in milling the under side of the lathe carriage as well as the gangs of formed cutters. It will be noticed that these are supported

FIG. 12. DRILL JIG FOR TAILSTOCKS

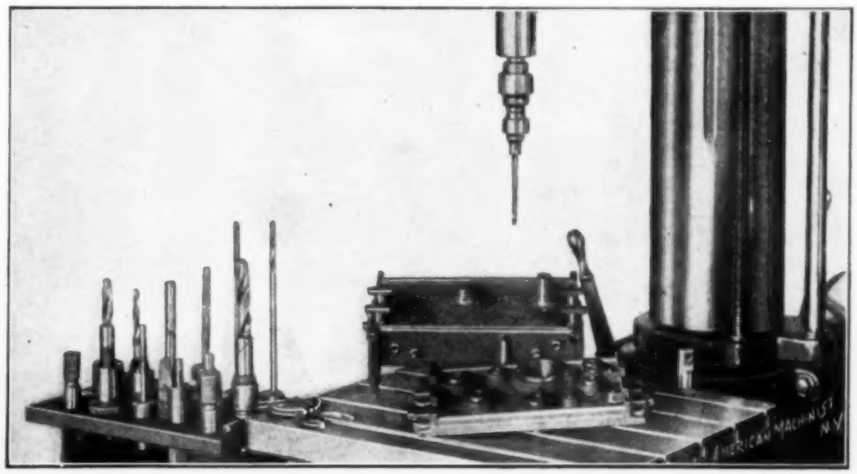


FIG. 13. DRILL JIGS FOR CARRIAGE APRONS

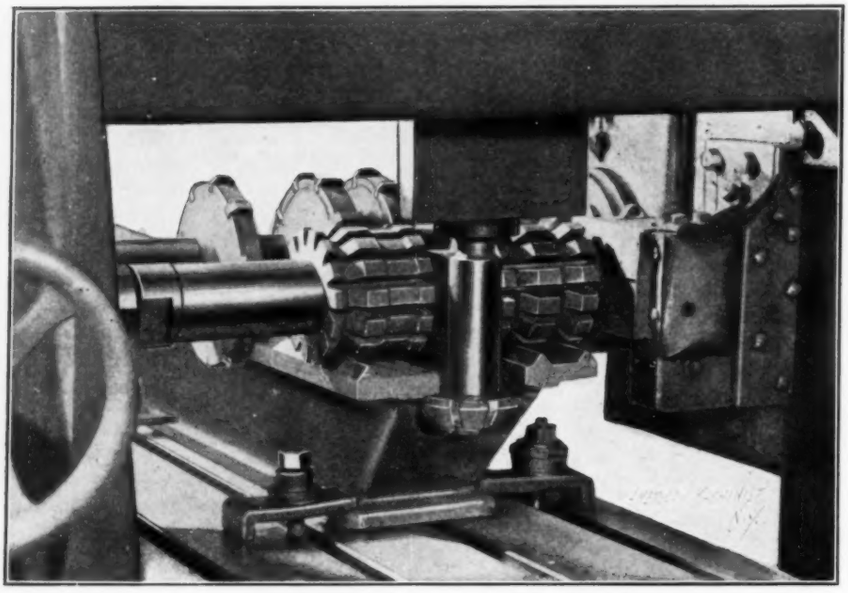


FIG. 14. MILLING THE LATHE BED

by the intermediate bearing to insure against springing away from the work. In Fig. 10 the top and side of the wing for the cross-slide is being milled with the carriage supported on the angle plate, shown. The cutter used is a somewhat unusual combination, consisting of an angular mill and a large inserted-tooth surfacing cutter.

Fig. 11 shows a milling fixture for the feed-worm bracket and illustrates the method of locating the piece as well as the clamp used in drawing the work down to a proper bearing. This sort of clamp is used quite extensively on the jigs and fixtures of this company and seems to have many good points.

Fig. 12 is a combination jig for drilling and tapping the tailstocks as well as the bottom for the side adjusting screws. As can be seen, both pieces are held in their relative position so that all holes will be properly located.

Fig. 13 shows the jig for drilling, reaming and facing the bosses and also for tapping on all sides of the apron. The top plate has been removed to show the apron in place, and the various tools and gages used are shown at the left. All tools are fitted with a uniform size of collet which may be inserted in the chuck without stopping it.

MACHINING THE LATHE BED

The lathe beds are first rough planed both top and bottom and set aside to season, the next operation being the milling, as shown in Fig. 14.

Another good example of surfacing by milling is shown in Fig. 14, where lathe bed is shown on a special milling machine which carries seven cutters on three different arbors. The leading arbor carries the four large inserted-tooth cutters for milling the sides of the lathe bed, both inside and out, while the cutters on the next arbor form the lathe bed with the three V's and the flat bearing surface. Lastly the vertical spindle faces the under side of the inside edges of the bed. After this milling they are allowed to season a second time before being finally finished on a long planer with a special head, as shown in Fig. 16.

Fig. 15 shows a very interesting tool head used in the finishing of the lathe bed which has been previously rough planed, seasoned and milled. This is a special head with a long apron in the tool block carrying the three special tool heads in addition to the plain flat tool which is held in the regular way at the right. The whole tool head feeds down at the correct angle for the V's, each tool having individual adjustment and after being properly set the beds can be finished very rapidly and accurately. The flat way is finished by the tool at the right which is fed horizontally along the rail, being set to the proper hight when the V-tools have finished their work.

Fig. 16 shows the follower rest used for supporting the thread tool while the thread is being cut. This supports the screw firmly on both sides of the cutting tool and practically does away with all tendency to spring. It will also be noticed that they use the compound rest set at an angle, for feeding into the cut.

The fixture for splining feed rods is

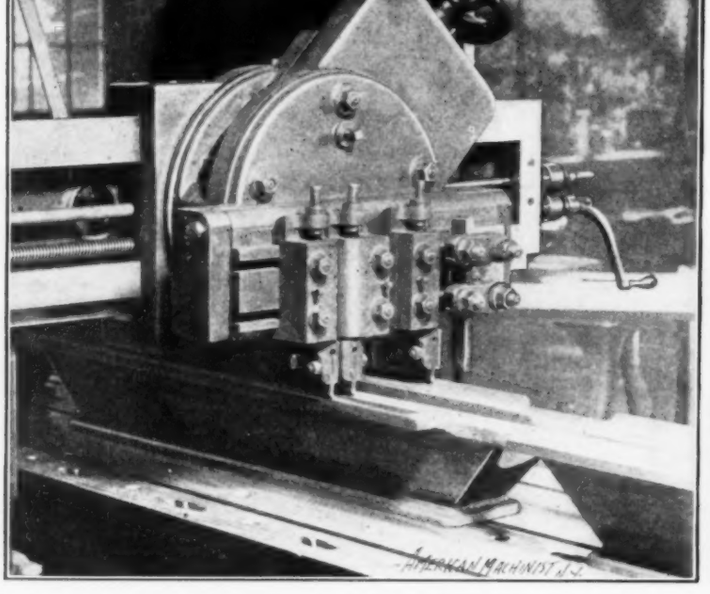


FIG. 15. FINISHING THE LATHE BEDS ON A PLANER

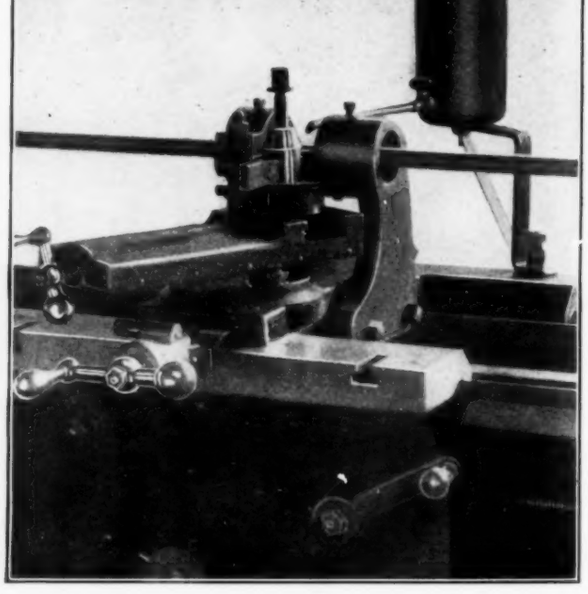


FIG. 16. FOLLOWER REST FOR CHASING FEED SCREWS

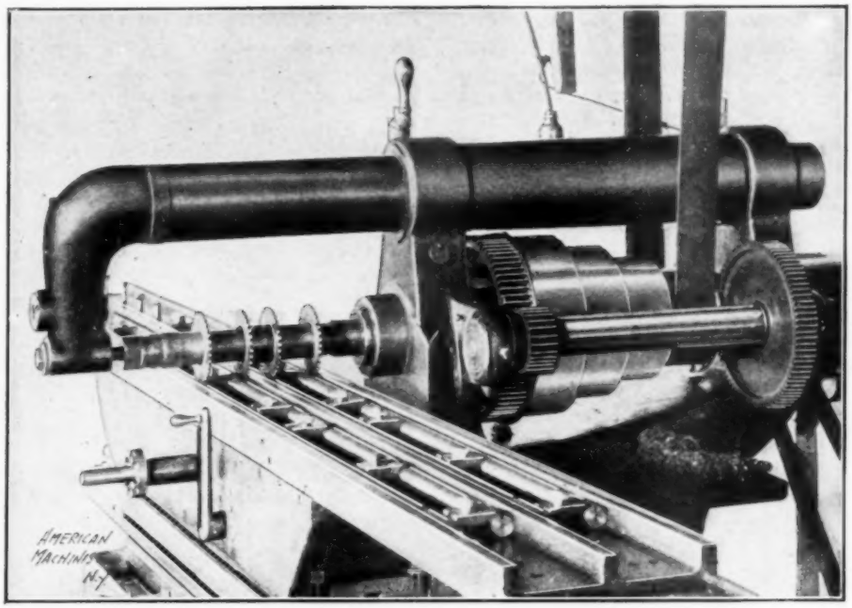


FIG. 17. SPLINING FEED RODS

shown in Fig. 17. This is practically a long table of double channel sections mounted on a base which fits on the regular milling-machine table. It has a power feed driven by the knuckle joint which is ordinarily used for the table of the milling machine. It is arranged so that the power feed can be easily disengaged and the long table quickly returned by hand when desired. Four cutters are used at the same time, so that the rods can be easily and quickly milled. This same fixture is used for splining the tail spindles, and will hold 40 tail spindles for the 9-inch lathe as made by this company.

Fig. 18 shows how the tails and spindles are tapped out. They are held firmly in the gripping fixture shown, which is held in any convenient vise, and the tap is guided by a hardened-steel bushing held in alinement with the bore of the fixture which fits around the spindle.

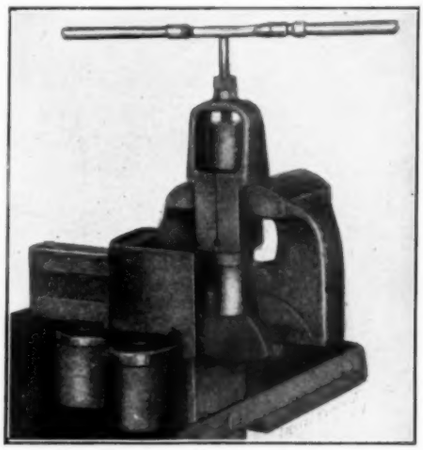


FIG. 18. TAPPING THE TAIL SPINDLES

METHODS OF TESTING

Before assembling, the headstock is thoroughly tested in every particular, the fixture shown in Fig. 19 giving an idea of how this is done. A hardened and ground arbor passes through the bearing

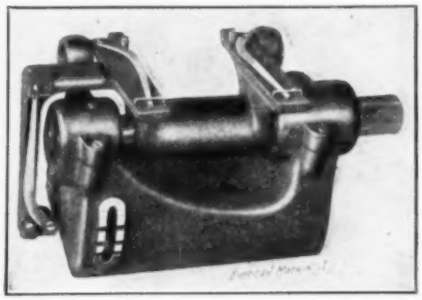


FIG. 19. TESTING INDICATOR FOR ENGINE LATHE HEADS

and supports the indicating fixture shown. This determines the location of the inside surfaces of the supporting arms for the back gear and also of the stud bearing in relation to the inside face of the front spindle bearing. The indicators show any variation, being held against the work by a spring, and the lever is being multiplied to read to thousandths of an inch. Eccentric nurled pins are provided to hold the fingers out of contact with the work when placing the gage in position so as to prevent any possibility of injury which might affect its accuracy.

A large special faceplate, Fig. 20, is used to test the accuracy of the spindle for alinement with the ways horizontally, and also for testing the squareness of the cross-slide with the spindle. A very

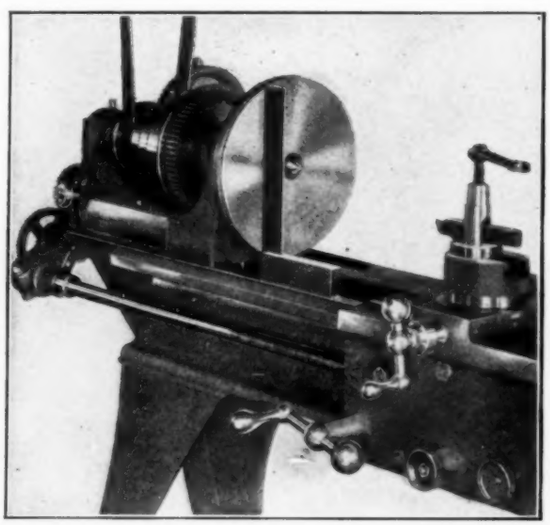


FIG. 20. TESTING SQUARENESS OF HEAD SPINDLE, WAYS AND CROSS-SLIDES

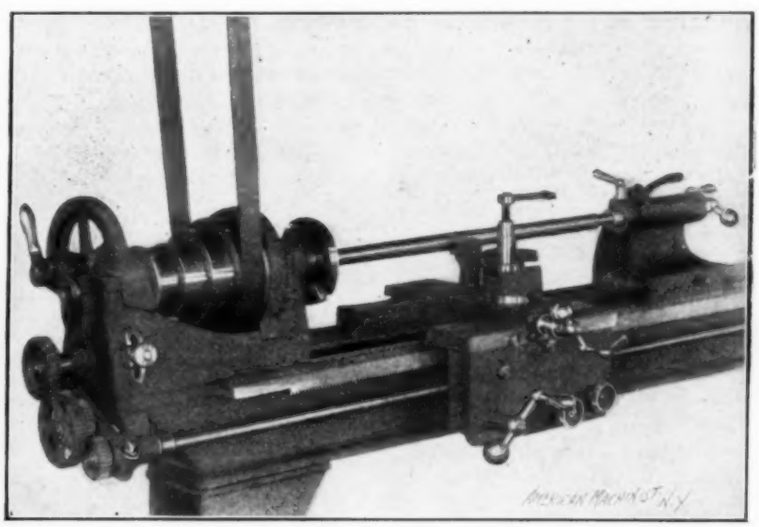


FIG. 21. TESTING ALINEMENT OF THE WAYS

light cut is taken across the faceplate with the power feed and a large square used as indicated, to discover whether the plate has been faced flat or not. This also indicates its relative position with the ways of the bed.

For testing the alinement of the spindle with the ways and also the accuracy of the lathe for boring, an arbor containing two collars is screwed on to the nose of the spindle as in Fig. 21. These collars are turned and finished by taking a very light cut with power feed and each collar measured with the micrometer, as shown. Any difference in their diameter shows the lack of perfect alinement and indicates the amount.

Fig. 22 shows the method of testing the alinement of the head and tail spindle. A round bar is placed between centers, and by means of an indicator held in the tool post, with the point against the bar, the tail center is adjusted to correct alinement sideways with the head center. Then by placing the point of the indicator underneath the bar, the alinement of the two centers vertically is determined. By testing tail spindles both in and out the alinement with the ways will be clearly shown. By running the carriage along and indicating at different points, the straightness of the outside or carriage ways can be proved.

Testing the Lead Screw

Accuracy of the lead screw is tested as indicated in Fig. 23. A plate with a projecting pin is attached to the carriage as at *A*, and a somewhat similar pin to the bed as at *B*. By means of a surface gage, a hairline is scratched on the periphery of the large faceplate, and a micrometer or vernier reading taken of the position of the two pins, *A* and *B*. Then the head spindle is turned the required number of times to move the carriage any desired distance, such as 1 inch or 1 foot, and the faceplate stopped exactly at the hair line. Then another reading is taken of the two pins, and a comparison of the two readings indicates whether the lead screw is too fast or too slow and how much. This has proved to be a simple and satisfactory method.

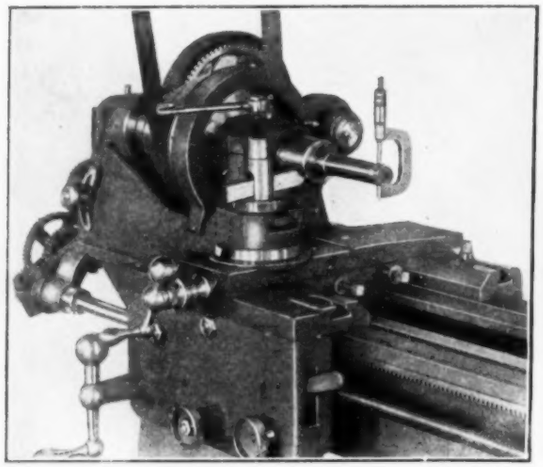


Fig. 22. Testing Alinement of Head and Tail Spindles

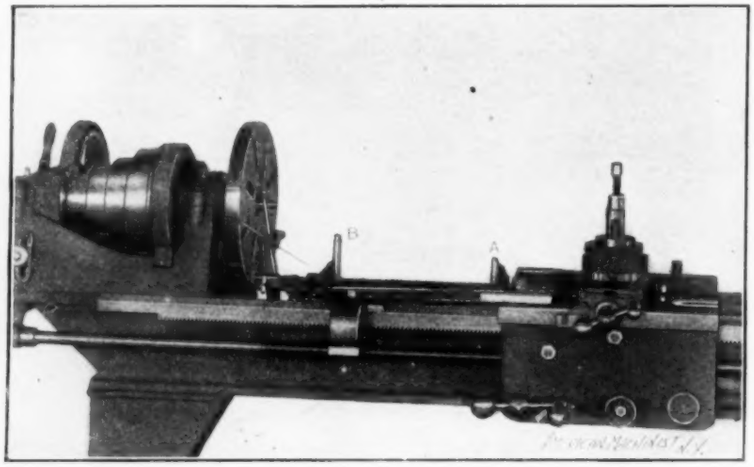
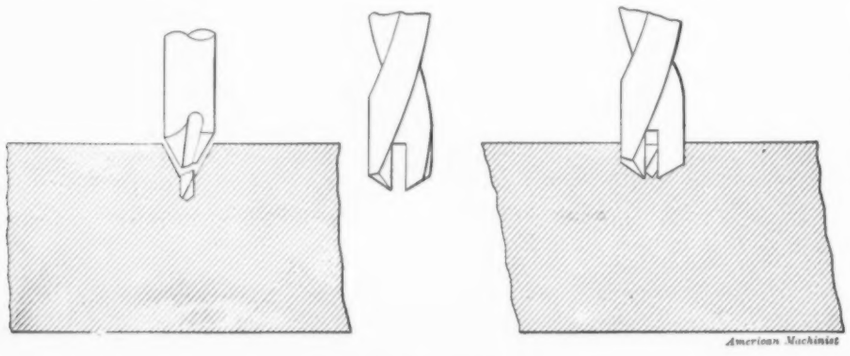


Fig. 23. Testing Accuracy of Lead Screws

Removing the Points of Broken Center Drills *By F. W. Cederleaf*

For doing accurate drilling many mechanics lay out the work, prick-punch it, start the hole with a small center-drill and then finish to size with drill and reamer.

This would be a good method if it were not for the irritating experience of having the center-drills break just as you get nicely started. This is not so bad when the piece of work is small enough to anneal without much trouble but when drilling large finished pieces and the broken point refuses to come out after a half hour of coaxing it is very annoying. The accompanying sketches show how to remove the broken points.



The Trouble and the Cure

I take an ordinary twist drill of a convenient size which must be smaller than the finished size of the hole and cut a slot in the end about the size of the point of the center-drill, using a thin flexible emery wheel. The slot should be a little deeper than the length of the broken point which is to be removed.

The drill centers itself in the hole that the center-drill started and after drilling the required depth the broken piece can be easily pulled out, the whole operation taking but a few minutes. I have used this method successfully for the last two years.

The copper production in the United States for 1909, according to statistics and estimates of the Geological Survey, reached the record-breaking figure of 1,117,800,000 pounds. This not only exceeds the increase of any previous year but it is considerably greater than the total yearly increase since 1904.

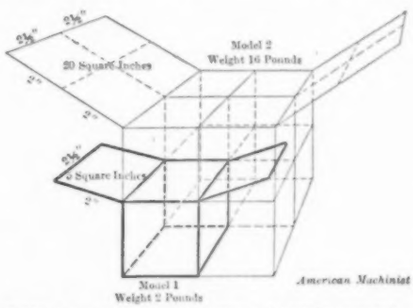
Financial Mechanics of Aviation *By M. C. Krarup*

Since it has been established that the art of flying is practicable, many persons with enthusiastic ideas on the subject are finding willing ears for projects involving important improvements which the discoverers of the art had apparently never thought of. Many of the projects are substantiated with small-size models, which may or may not fly. If they do fly, the promoter has his case proved; and if it does not fly, it is because there is something in the construction which absolutely requires life size and a powerful engine, "as anybody ought to be able to see." The majority of the projects relate to improved monoplanes or biplanes; some take a middle ground between a Zeppelin rigid balloon and an aëroplane, and quite a few represent ambitious attempts at the construction of ornithopters, helicopters, ornithoplanes, gyroplanes, or perhaps a gyroscopic nondescript altogether of its own kind.

The inventors, promoters and financial backers are all interested, it would seem, in certain simple mechanical laws which apply to all of these types and in deciding for themselves what can be proved by a model and what cannot be so proved, what kind of construction is most likely to prove a failure and what kind has a good chance in its favor. The mechanics relating to the balancing of fliers under all sorts of conditions are admittedly intricate and disputable, but those relating to sustentation and strength are fortunately so simple that anybody who has money to invest in experiments can understand them and profit by them. Perhaps they might be termed the financial mechanics of aviation.

Beginning with the question of models, suppose a small flier model operates with a surface of wings, or planes, or helical lifters, of 10 square inches and weighs 2 pounds. If one just like it in all proportions but twice as large in all linear dimensions were built it would be found that its active surfaces comprised 40 square inches and that its weight was 16 pounds.

The accompanying diagram shows plainly the reason for these proportions and is applicable whether the shapes are square or elongated, flat or bulky. The small first model could fly, it is assumed, because its action was suitable for lifting 1 pound with every 5 square inches of acting surface, but the second and larger model has only 2½ square inches of acting surface for each pound of weight. The problem of making it fly is a new one, although it is an exact counterpart of the model which flew, only larger. Its eight times greater weight represents presumably an eight times greater power wherewith to actuate four times greater surfaces, and it can move them faster than the small model could move its surfaces. How much faster? The linear speed of the centers of pressure in the surfaces can be multiplied by the square root of two, because this will make the resistance twice as great, corresponding to the double power per square inch. But it is a question to be decided only by experiment if the quadrupled surfaces, when moved at a velocity $\sqrt{2}$ times higher than the velocity used in the small model, will thereby sustain an eight times greater burden.



Model 1, In Heavy Lines, has a Wing Surface of 5 Square Inches per each Pound of Weight.
Model 2, In Thin Lines, exactly twice as large in linear dimensions, weighs 8 times as much, and has only 2½ Square Inches of Wing Surface per Pound of Weight.

GRAPHICAL COMPARISON OF TWO WINGED MODELS, THE ONE HAVING LINEAL DIMENSIONS TWICE THOSE OF THE OTHER

In the case of ornithopters and helicopters, the increased velocity required of the larger model means in reality fewer wing flops per second and fewer revolutions of the helical lifters per second, because the centers of pressure, being twice as far removed from the axes of motion as in the small model, would be moved twice as fast by an unchanged number of flops or revolutions, and they can only be moved $\sqrt{2}$ or 1.414 times faster by the available power. In other words, it may be said that the larger machine will have to sustain a larger weight with a relatively reduced flying equipment and with an absolutely reduced number of wing flops, or revolutions of rotary sustaining surfaces. It is by no means impossible that it can do so, because it is not really the number of wing flops or revolutions that count for most, but the linear velocity of the centers of pressure in the acting areas, just as in an engine it is the linear piston speed that counts and not the revolutions per minute of the crankshaft. But, on the other hand, the conditions are so different, that the small model proves very little in favor of the larger one and much less in favor of a life-size flying machine.

One complication is immediately apparent, for if the larger machine is proved in practice to be capable of flying, its speed should be greater than that of its smaller sister, because with eight times greater power it has only a four times greater air resistance to overcome. It should fly 1.414 times faster. Somewhere in its operation it has to pay for this speed. Inferences are unsafe. Each dimension must be proved out for itself, somewhat on the same principle as each size of a two-cycle gasolene engine must be proved out for itself.

Further—for in aviation nothing must be overlooked—if the wing motion is such that increased forward motion in space contributes notably to weight support, as it ought to, the larger machine has here a point in its favor, provided it is capable of starting. Large size, for this reason, seems to tend toward the aëroplane system, in which the forward speed produces the whole weight support. And the question of models need not be discussed for aëroplanes, since aëroplanes have been tried in full size, and their success or failure does not begin to be considered, till they have been proved capable of leaving the ground.

AN EXAMPLE OF INTEREST

An example may prove of interest, even if the figures used may not be quite true to nature. A bumble bee has a wing span of about 1½ inches and flies with about 16 flops per second—textbooks credit it with much higher speed, but a musical-vibration test gives only 16. The wing tips thus move up to 80 inches per second, assuming a full semi-circular stroke for each wing.

A dove has a wing span of about 15 inches, 10 times greater than the bee's, and flies, when not in a hurry, with four to five flops per second, giving the wing tips with full stroke 188 to 235 inches of travel per second, or 2¼ to 3 times faster than the bee's. The centers of pressure work, of course, in the same proportions as the wing tips.

Squaring the velocity, the efficiency of the dove's wing stroke is seen to be five to nine times superior, but, on the other hand, the dove has to support weight about 1000 times greater with a wing area only about 100 times larger. There would be a deficiency, if it were not that the dove's forward speed in space contributes to support; the dove's speed being the $\sqrt{10}$ times greater than the bee's, as it has a 1000 times greater power for propelling a 100 times greater surface. Also, the bee is a flier that frequently carries a heavy burden, and it seems not improbable that its power may be relatively greater, while its shape is no doubt less favorable for speed.

All that it has been desired to show

is that the relations between the flying capacity of a machine of a given size and that of an exactly similar machine of a different size are not simple but quite complicated, and that quick inferences from one to the other are in conflict with the laws of mechanics.

Even the question of materials alone precludes all acceptance of evidence from models, especially in the case of machines in which large areas are agitated by power against the resistance of the atmosphere. The properties of rigidity (or flexibility) and resiliency in the wings of the small flyer, or model, undergo very considerable changes which are not at all in simple proportion to the increase in linear dimensions, and it is more than doubtful if any material can be produced in which the changes will be suitable for and in proportion to the higher velocity and higher resistances demanded when larger dimensions are used. Even in aëroplanes, to produce rigidity or a certain degree of flexibility, new construction is required for each size.

Another set of mechanical ideas which should be of interest to promoters of aviation projects relates to dynamic stresses—the same kind which for a long time rendered automobiles liable to breakdowns.

Graduating Hardened Steel Scales *By Fred H. Colvin*

The graduating of steel scales, particularly those which are hardened, has given rise to much speculation on the part of mechanics in general, and we are confident that the graduating and engraving machine which is now illustrated through the courtesy of its makers, John Hope & Sons, Providence, R. I., will prove extremely interesting to all of our readers.

The old dividing engine, which might be compared to a traversing shaper with a very accurate screw, has given way in all commercial work, such as the graduation of steel scales, to machines of the type illustrated herewith, as it enables a large number of pieces to be graduated at one setting, according to the number of diamond points used, the machine illustrated being capable of graduating 24 pieces at once.

While this embodies the well known pantagraph system, the way in which it has been worked out so as to insure extreme accuracy and enable the work to be done rapidly is extremely interesting to the mechanic. This system involves the use of a pattern or master scale, which is made several times larger than the work to be produced, and, in the case of scales for obtaining fine measurements, must be laid out in the first place with extreme accuracy. This pattern or master is secured on the table *A* which forms the bed of the machine so that its markings may be followed or traced by the hardened steel pointer *B* which is controlled by the operator. The master scale also contains all numbers and markings, such as the makers' names, which are reproduced on all the pieces on the work table at one operation.

How the Movement Is Transmitted

This pointer can be moved freely up and down, but its connection to the frame *E* is by two widely separated bearings which prevents any lost motion sideways. The pointer *B* is free to move in any direction as is necessary in following patterns of irregular design, but for the purpose of making graduations, we need only consider the forward and back motion and the travel along the plate *C* in moving from one graduation to the next. When the pointer is pushed back, the frame *E* and plate *C*, which is mounted on wheels *D*, all move back with it. The arm *G* is swung backward by the ball pointer in the end bearing in the planed V in the top of bracket *H* and transmits a similar but reduced motion to the work table *K* through the opening in *J*. These motions can be traced by the aid of the three views, although the back view shows a different machine, but the operation is the same.

When the pointer *B* is moved sideways the frame *E* moves along the top of the plate *C* and arm *O*, which can be seen in the rear view and which has a ball pointer similar to *G* bearing in a planed V in the top of *E*, swings the arm *N* through the connection *M* and imparts a side motion to the carriage *J*.

Graduating the Work

The work to be graduated is held on the upper table *K*, being located in its proper position so as to have its marking conform with that of the master scale with relation to the starting point. When the operator wishes to make a cutting stroke, the treadle is depressed, which throws all the diamond points into contact with the work, and as they are under direct control of the pointer *B*, every movement of the operator is reproduced by each cutting point, but on a reduced scale.

These cutting points are made from diamond chips, which are securely

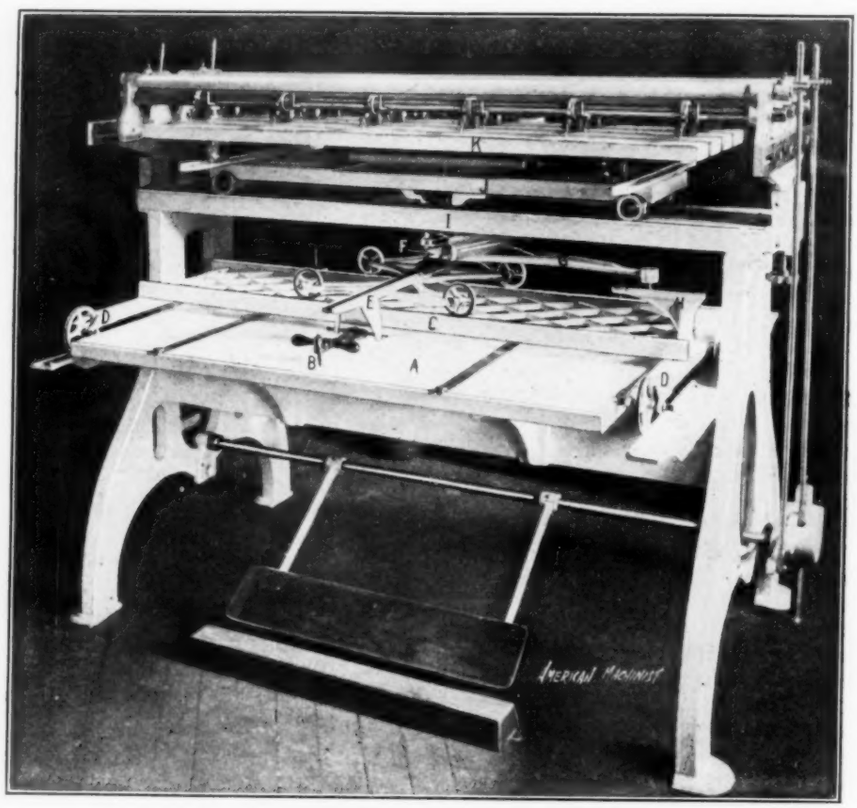


Fig. 1. Engraving Machine for Grading Steel Scales

mounted in steel holders and then ground and lapped down to a fine cutting point. They last a long time, as, contrary to general opinion, they are not used to cut the hardened steel itself.

Etched After Graduating

After the pieces to be graduated have been hardened and tempered, they are ground to the desired thickness and also to present a perfectly smooth surface. They are then given a thin coat of asphaltum varnish, which is known in the trade as "acid resist," and they are then ready for graduating. The diamond points cut through this varnish to the steel, leaving it exposed to the action of the etching acid into which the scales are dipped. A careful study of these illustrations, using the reference letters in each case, will give a good understanding of the way in which the machine works, and also show how the accuracy is secured by using widely separated bearings, easy running wheels (which are now being made with ball bearings), and give a very good general idea of the way in which this kind of work is performed.

The top view shows nearly all of the 24 diamond points, shows how they can be adjusted into any desired position for different work, and how they are brought down to the work by the rods connected with the foot treadle.

Very similar machines are used in engraving copper rolls for printing wall paper and textile fabrics, the main difference being in the arrangement for holding the rolls to be engraved and the mechanism for controlling the diamond points. It is interesting to note that this machine is the outcome of nearly a century of experience in textile engraving, the House of Hope being founded in Manchester, England, in 1810, and established in Providence, R. I., in 1847. Many improvements have been made since the beginning and a large number of these machines are now in use for the finest kind of graduating and engraving.

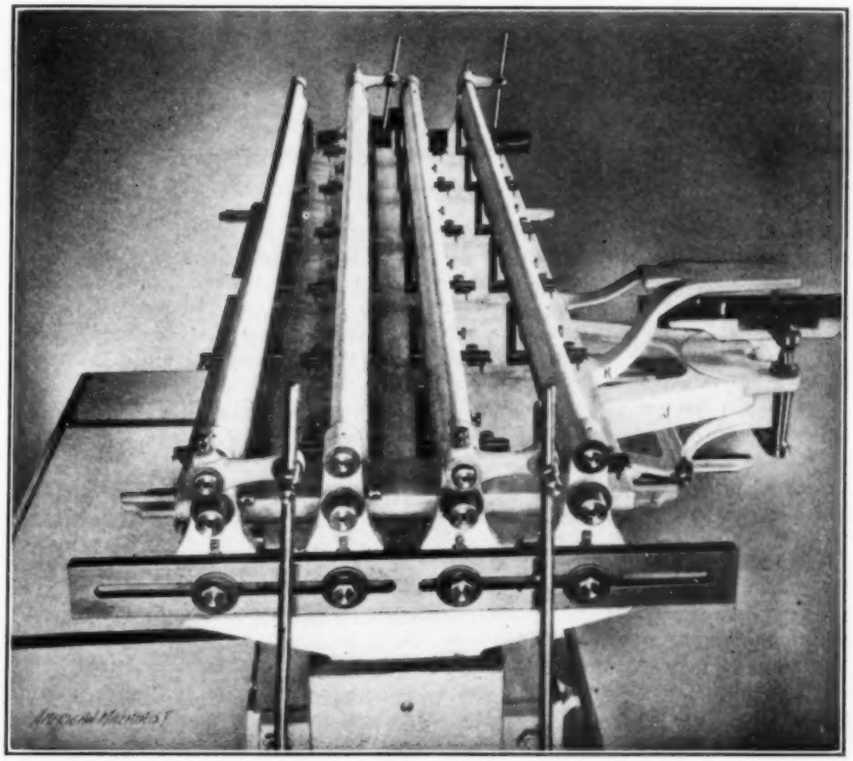


Fig. 3. Looking at the Work Table

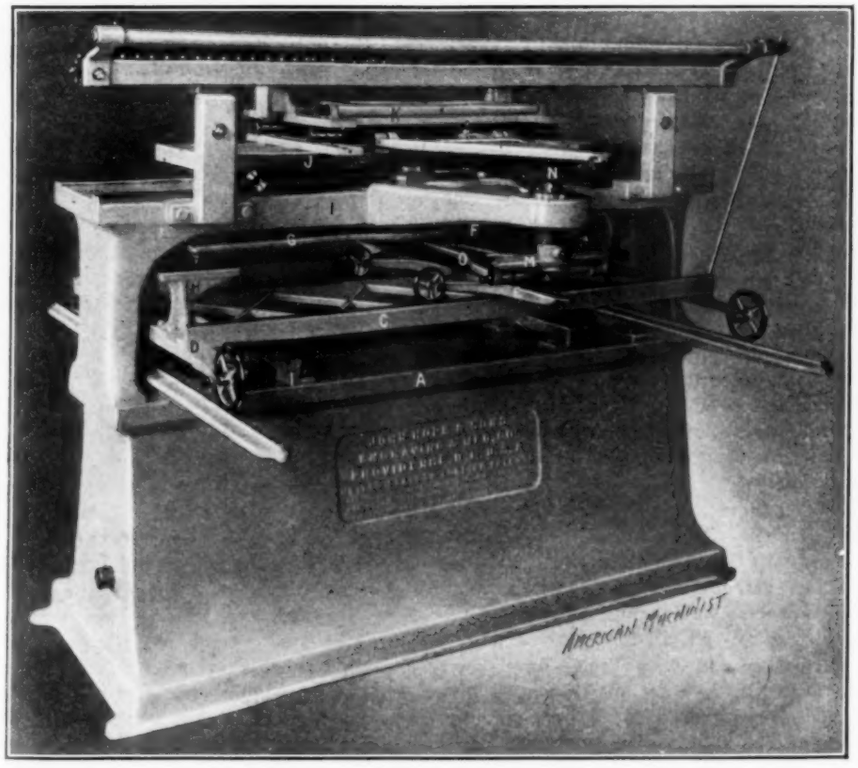


Fig. 2. Rear View, Showing Reducing Arms

Permanent Expansion of Cast Iron

In May, 1909, Crane Company, according to the *Valve World*, made two straight bars of cast iron, ¼x½ inch, accurately machined. One bar measured 18.336 inches and the other 23.382 inches. These bars were placed in a steam-heated core oven, where there is an even temperature of 325 degrees Fahrenheit. At the end of five weeks the shorter bar had a permanent expansion of 0.003 inch, and the longer, 0.008 inch, the lengths being 18.339 inches and 23.390 inches. In July the bars were transferred to a second oven in which the temperature fluctuates a little, but averages 600 degrees Fahrenheit. After being in this oven 30 days the lengths had increased 0.145 inch and 0.177 inch. The bars were then returned to the oven for another 30 days and gained 0.014 inch and 0.028 inch, respectively, in the second period.

	Inches.	Inches.
Original lengths	18.336	23.382
Gain in five weeks at 325 degrees	0.003	0.008
Gain in thirty days at 600 degrees	0.145	0.177
Gain in thirty days at 600 degrees	0.014	0.028
Final lengths	18.498	23.595

The permanent expansion at a temperature of 325 degrees was very small, but at 600 degrees it equaled in 60 days 0.104 inch per foot on both bars.

SOME HARDSHIPS of PATENT INTERFERENCE

Radical Changes in System Demanded to Stimulate Invention

BY L. P. ALFORD

Were certain phases of our United States patent system designed to protect the rights of the inventor, or to rob him of them? Before answering, consider the heartbreaking, almost unending, complicated and tremendously expensive litigation through which an inventor may be compelled to go in upholding his rights. Consider again that this same litigation is a most powerful weapon in the hands of unscrupulous parties in their fights with the independent inventor.

This article gives a striking account of the manner in which, through the incompetence and carelessness of the examiner, the rights of inventors are constantly placed in jeopardy by the United States Patent Office. It shows how cases that should be declared in interference are constantly overlooked, with the result that patents are issued beyond recall to the later of two inventors; and how ceaseless vigilance on the part of the inventor is necessary to reduce, although it cannot remove, the cloud thus placed on his title to his invention. It shows the kind of a fight the rightful inventor may have to make to obtain his patent, after the other party has had his issued. And even then, each patent carries the seal of the Patent Office, and on its face one is as good as the other. If the defeated party is not satisfied with the result, and defeated parties are seldom satisfied, he may, without even the formality of an appeal, start an infringement suit and try the case anew, for the interference proceedings have no standing in court. On the other hand, he may begin manufacture and thus compel the successful claimant to institute an infringement suit in order to prove that his rival's patent is not valid.

This article deals with facts, some of the experiences in patent interferences, of a single independent inventor. In the title I have written "hardships;" this might well have been "injustices," for interferences present the clearest proof, to those who study them, that the administration of our patent system is radically unjust and that the intent of the Constitution both in promoting the progress of science and useful arts and in securing for a limited time to inventors the exclusive right to their discoveries is not realized. There are hardships imposed and injustices done, both to the public as a whole and to the inventor as an individual.

Purpose of the Article

This article sets forth facts in regard to certain patent interferences in order to show the hardships that this branch of our patent system imposes upon inventors. Thus it is added testimony to the general unprofitableness of inventing and patenting, and, therefore, directly in line with the conclusions set forth in a preceding article printed on page 221, Volume 32, Part 2.

Records of a Well Known Inventor

H. Ward Leonard, of Bronxville, N. Y., is one of the best known inventors in the United States today. His work has been more particularly in the electrical field in which he was a pioneer, and many of his inventions are used in this country and throughout Europe, and are known under his name. Mr. Leonard has had 64 patents granted to him, of which about 50 have proved to be valuable. In addition he has some 30 patent applications pending. In connection with these 94 patents that have been issued or are pending 30 interferences have been declared. Of these 10 are now being contested, 15 were finally won by Mr. Leonard, 3 were settled by compromise and 2 were lost through neglect of the attorney that had them in charge.

The fact that all of these interferences had been declared is presumptive evidence that the inventions are of value; for expensive interference proceedings—and such proceedings are extremely expensive—are not carried on unless each contestant believes that there is real value in the invention and in the claims that are in controversy. Again, the fact that out of 20 interferences that have reached final decisions Mr. Leonard has lost but two, and that loss directly traceable to the neglect of his then attorney, and that only three others have been compromised; or, to put it a little differently, the fact that he has won, wholly or in part, 18 out of 20 interferences is presumptive evidence of the value of his inventions and the strength of his patent applications.

It is doubtful if any other inventor in the United States has as complete records of his patent applications, the various amendments and motions made in connection with them, and as complete a history of all of the various patent interferences in which they have been involved. It is especially fortunate that such information can be drawn upon for this article in order to show the hardships and injustices of patent interferences.

What the Record Shows

The record shows that many patents issue through inadvertence; that is, their applications should be put in interference with applications already on file in the Patent Office, instead of being allowed. For this reason a careful inventor is compelled to study the *Official Gazette* week by week to discover or surmise, if possible, from the few claims that are printed whether or not a patent has issued with claims that interfere with any applications he may have in the Patent Office. A patent that is once issued, even although its claims are finally given to another through interference proceedings, is irrevocably issued, is not canceled and constantly exists as an encumbrance upon the clear title of the second patentee; for, superficially, the first inventor has priority in the claims, and may always assert his claims in a legal suit for infringement.

This record also shows that interference proceedings are so lengthy and expensive that a man who is not possessed of considerable means cannot carry them through to a conclusion, even if there is no question in his mind, or in the minds of his attorneys, that he has the right of the controversy. During the period when such controversies are being carried on, an inventor cannot market or sell his product without taking a chance that the decision may be given against him and that he may be held accountable for infringement.

This record shows, still further, that established priority of invention, and even the filing of an application in the Patent Office prior to any date of conception alleged by contestants in an interference contest are not sufficient grounds to ward off appeal after appeal.

Two Illustrations

From Mr. Leonard's records of 30 interferences we have selected two illustrations of the extent to which interference proceedings can be carried under existing practices. The first has seven interferences, the second, three. On March 25, 1902, a patent, No. 696,247, issued to Leonard for an electrical multiple-control system; the application was filed January 24, 1901. This was a parent or basic patent, requiring several divisional patents in order to cover the various patentable disclosures of the original application, but which could not be claimed specifically in the original patent. Various rules have been enforced from time to time at the Patent

Office in regard to what may or may not be included in one application, if the inventor proposes to patent both combination and method. In this case basic patent 696,247 with the rules then in force was limited to combinations, therefore the specific forms claimed in that patent were the combinations of Fig. 1 of the application.

On March 22, 1902, just prior to the issuing of the basic patent, a divisional was filed, serial No. 100,142, covering the specific disclosures of Fig. 4 of the parent application. Since that time the rules of the office have been changed so that both methods and combinations can be claimed in the same patent.

On May 9, 1901, a divisional application, No. 59,373, was filed covering the methods employed in connection with the combinations of Fig. 1 of the parent application, which at that time the rules of the Office did not allow the parent patent to cover.

Illustration 1. The First Interference.

On November 29, 1904, patent 776,220 was issued to Cutler for an invention covered by the divisional application serial No. 100,142, filed March 22, 1902. Leonard noted this patent, realized that it interfered with the application which he then had in the office and demanded an interference. This the examiner refused to grant.

Meanwhile, Leonard's application had been allowed, but if it should issue it would have contained claims paralleling claims already allowed and issued to Cutler. Leonard, therefore, forfeited the application after having asked the examiner to declare an interference with Cutler and being refused. This forfeiture took place on May 11, 1905. On July 26, 1906, Leonard renewed it, having a right to renew at any time within a period of two years from the date of allowance. He then again demanded an interference, which was granted November 6, 1906. The alleged date of conception by Cutler was about October, 1902, and the examiner of interferences awarded priority to Leonard.

On appeal to the examiners-in-chief the decision of the examiner of interferences was reversed on the ground that the delay of 14 months between the date of forfeiture and the date of renewal constituted an abandonment of the application.

Upon appeal to the commissioner the decision of the examiners-in-chief was reversed and priority was again awarded to Leonard.

The case was then taken to the Court of Appeals of the District of Columbia and a decision rendered in favor of Leonard May 5, 1908, and published in the *Official Gazette*, September 8, 1908.

Special attention should be called to two points in connection with this case: First, that the Patent Office allowed a patent to issue inadvertently at a time when an interference should have been declared with an application of prior date still pending; second, although Leonard's filing date was prior to the alleged date of conception of the other party to the interference he was forced to spend both time and money in order to carry the case through the primary examiner, examiner of interferences, examiners-in-chief, commissioner, and court of appeals, in order to establish his right to an invention disclosed in his original patent application.

Regarding Inadvertence

In regard to the point of inadvertence I quote from the court decision referred to above:

"Leonard's application was pending when the patent to Cutler was granted, and, in view of the subsequent decision of the Patent Office that an interference existed, it necessarily follows that the patent to Cutler was inadvertently issued.

"The real question in the case is whether the inadvertence of the Patent Office in granting a patent to Cutler without declaring an interference between Cutler's application and Leonard's divisional application and subsequently erroneously declining to declare an interference between the Cutler patent and Leonard's divisional application, shall be held to be a bar to the renewal of Leonard's divisional application. To state the proposition, we think, is to answer it. Until the patent to Cutler was granted Leonard had no means of knowing what claims it contained. As soon as he heard of the patent he asked for the declaration of an interference, which it was subsequently determined he was entitled to have. Manifestly the patent to Cutler was not regularly issued as contended by his counsel, but was inadvertently issued at a time when an interference should have been declared. Every principle of justice and right, therefore, demands that Leonard be not permitted to suffer because of the mistake or inadvertence of the Patent Office."

Illustration 1. The Second Interference.

Meanwhile, the patent office had inadvertently issued four other patents whose applications should have been put in interference with a second divisional application of Leonard's under this same parent patent No. 696,247. This divisional was filed April 24, 1903, serial No. 154,089. These four patents were issued to Powell on September 10, 1907, No. 865,812, filed April 16, 1906; No. 865,813, filed June 30, 1906; No. 865,815, filed September 29, 1906; No. 865,816, filed July 30, 1906.

Leonard noticed these patents and demanded an interference, which was granted January 7, 1908, interference No. 28,375. Twenty-eight counts were in controversy. Powell's alleged date of conception on each and every one of the 28 issues was *subsequent to Leonard's filing date*. On Feb. 21, 1908, the examiner gave notice of a decision in favor of Leonard unless good and sufficient cause should be shown why such action should not be taken. Powell made a motion upon 23 different grounds to dismiss the 28 issues. This was on March 21, 1908. After a very elaborate and complicated argument the examiner awarded priority to Leonard on July 9, 1908, in regard to 12 of the counts at issue and dismissed the others. Leonard and Powell mutually agreed not to appeal from this decision and it became final on August 31, 1908.

Illustration 1. The Third Interference.

On September 10, 1907, another patent improperly issued from the office, one that should have been put in interference with this same application of Leonard's, No. 154,089, filed April 14, 1903. The patentee was Bogen; patent No. 865,822; application filed May 27, 1907. Upon a demand from Leonard an interference was declared January 27, 1908, No. 28,376.

As Bogen's alleged date of conception was *subsequent to Leonard's filing date* the examiner gave notice of judgment for Leonard. The interference had two counts. Bogen moved to dismiss upon March 31, 1908. Upon July 9, 1908, the examiner decided in favor of Leonard upon all the issues and, as the contestants agreed not to appeal the decision became final upon August 31, 1908.

Illustration 1. Four More Interferences.

Later four other interferences were declared at the request of Leonard, two with Powell, one with Bogen, the rival inventors mentioned before, and the fourth with another inventor named Richards. The second interference with Powell, No. 29,476 was with one of Powell's patents that had been in interference before, No. 865,812 and Leonard's divisional application, No. 100,142, which had been in controversy with Cutler. The other Powell interference, No. 29,600 was between this same patent 865,812 and Leonard's application 59,373. Bogen's second interference was between his patent that had been in interference before and Leonard's divisional application, No. 100,142. This interference was No. 29,427. The interference with Richards, No. 29,428, was between his patent No. 867,154 issued September 24, 1907, and Leonard's divisional application, No. 100,142.

Of these four interferences it is interesting to note that three are with the divisional application that was put in interference with Cutler's patent and carried through to a decision in favor of Leonard.

These four interferences are in controversy at the date of this writing, the situation in regard to each being briefly as follows: No. 29,426, Powell No. 2, five counts are involved. The decision of

the examiner of interferences of December 16, 1909, gave four counts to Leonard and held the fifth as not patentable.

No. 29,427, Bogen's interference No. 2, nine counts are involved. The examiner of interferences rendered a decision on December 16, 1909, awarding eight of the nine counts to Leonard and holding the other as not patentable.

No. 29,428, interference with Richards, only one count involved. The examiner on interferences decided in favor of Leonard on December 16, 1909.

No. 29,600, Powell interference No. 3, three counts are involved. On December 16, 1909, the examiner decided in favor of Leonard on all three counts.

Resume of the Situation

Thus we have this situation: In connection with this one inventor's copending applications on the same general subject matter the Patent Office has allowed seven patents to issue inadvertently, this being proved by the fact that upon Leonard's demand interferences have been declared between certain claims of these seven patents and certain claims of Leonard's applications. As these patents have issued and as certain of their claims will likewise ultimately appear, presumably, in patents to be issued to Leonard there will be a confusion to the public. The improper patents will be of prior date and superficially will appear to a layman to be the valid ones. Eight years have been spent in fighting these interferences alone and many thousands of dollars. Behind all this stands the fact that Leonard's original filing date was *prior* to any date alleged as the date of conception by the other inventors. The last four interferences mentioned have presumably but started on their course, and it will probably take a long time and a large sum of money to carry them through the Court of Appeals. Where is the justice to any of the interests involved in such procedure?

Illustration 2. Three Interferences.

To show that the conditions that have been described are not necessarily caused by the extreme technicality of electrical inventions, another invention of Mr. Leonard's in an entirely different field and under entirely different conditions is worth citing. This is an invention dealing with an automobile clutch; today there are three interferences in controversy in connection with it; No. 29,809 of January 18, 1909, No. 29,810 of January 18, 1909, and No. 30,833 of September 30, 1909. The application was filed in 1903. The Patent Office is considering the application at first refused to believe that the invention now in interference existed. However, at length through continued argument the examiners were brought to see that the invention claimed did exist. Before the application could be prosecuted to allowance, three other inventors entered the office with devices which have been declared in interference with it.

This situation shows plainly the fallibility of the examiners. The assumption upon which the examination rests is that a man earning perhaps $1800 a year, is competent to review the art upon which a great industry is based, and differentiate just how far a new invention furthers that art, and at the same time delimit the claims to just exactly that which is a progress over the art as it existed before the invention was made, no more and no less. In regard to the application just cited, some five years were required to convince the office that an invention had been made; and after that point was reached, other inventors had reached the office with substantially the same material so that long drawn out and expensive interference proceedings must result. Had the office taken the attitude in 1903, that it took at a subsequent date, there is apparently no reason why the patent could not have issued within a reasonable length of time. Thus four inventors must presumably spend much time and money in a fruitless fight, and the public will not have the full advantage of the invention for several years to come.

Can anyone who has read the preceding paragraphs doubt that our patent procedure is rotten? Can anyone doubt that real invention is being hampered and suppressed, rather than stimulated through the hardships to which inventors are placed once they try to patent their inventions? Can anyone doubt that the spirit of our Federal Constitution is being violated in that neither the public nor the inventors are getting, on the one hand public benefit of new inventions, and on the other hand the individual right to be secured in the exclusive right to the invention for a limited length of time? Can anyone doubt that an intelligent and immediate reform of the patent laws through the agency of Congress, and in the interests of both the public and inventors, is needed?

There is probably no experienced independent inventor in the United States who is satisfied with present conditions. On the contrary, however, many patent lawyers will state that the patent procedure of the United States is the best in the world, and so it probably is from their selfish point of view.

Hardships to Inventors

To summarize briefly some of the points brought out by the paragraphs from Mr. Leonard's experience: The Patent Office examination is insufficient, in that it allows many patents to issue through inadvertence. This must not be construed too harshly, for is it conceivable than any one man can know the exact state of the art behind a great industry and appreciate the precise limitations of every invention in that field?

The Patent Office examination is in some cases insufficient to determine whether or not an invention has been made, and if a considerable length of time is required for an inventor to show the office that inventions actually exist he is constantly exposed to the danger that some other inventor may have reached the office with the same disclosure and a long drawn out and expensive interference contest will result.

From the fact that patents issue inadvertently, a careful inventor is compelled to study the *Official Gazette* week by week in order to see, if possible from the limited number of claims that are now printed, whether or not a patent has issued inadvertently, interfering with some application that he may have on file in the office. This fact alone should be sufficient to base a demand upon the Patent Office that the former system of printing all of the claims of every patent be returned to. It is now an easy matter for unimportant claims to be placed among the first five, all that are printed by the office, and important claims given succeeding numbers. Thus an inventor is put to the hardship of sending for a large number of patents, if he has worked in an active field, in order to determine whether or not his rights have been invaded, or take the risk of having a patent issued to some other inventor containing claims to which he is justly entitled but of which he has no knowledge.

In case a patent issues inadvertently, or an interference is declared in connection with a patent application upon a device which an inventor wishes to manufacture and market, he is compelled to desist from such manufacture, or else run the risk of losing the claims which are in controversy and place himself liable to an infringement proceeding from his competitors, for never mind how just his position may be as he is able to see it, he cannot forecast with certainty the nature of the decision that will be ultimately rendered.

The real inventor who seeks to protect his rights properly is compelled to spend an enormous amount of his personal time in looking after his interests, particularly if he has a number of interference proceedings on hand. When an inventor is fighting interference proceedings and the like in the Patent Office he is not inventing, thus the value of his creative genius is being lost, both to himself and to the public at large. Such losses are, of course, incalculable, but the fact is growing more and more prominent that the best of the independent inventors of our country, especially those who are the philosophical ones, are not patenting many inventions today. Mr. Leonard estimates that two-thirds of his own time is spent in connection with patent litigations; time that he would gladly spend on new inventions if he could do so.

Admitted priority of invention is no

protection to an inventor from interference proceedings. In all of the seven interferences in connection with the electrical inventions referred to above, not one alleged date of conception of the other applicants was prior to the date of filing the original application of Mr. Leonard. Yet various technical grounds can be brought up to prolong a contest, even under conditions where the junior party cannot contend that the senior party was not the prior inventor. Why should not established priority be sufficient grounds upon which to base an incontestable decision?

Through the inadvertence of the Patent Office, a patent may issue irrevocably to the wrong men; and after a prior applicant has spent thousands of dollars and years of time in carrying through an interference proceeding—when it is all finished and he has gained his decision—he is still lacking the security in the exclusive rights to his invention that the Constitution of the United States clearly intended he should have.

Other Hardships

In connection with the cases that have been described, one fact should be plainly recognized; that is, that in no case did Mr. Leonard take testimony in any of the interference proceedings. His date of application in every case was prior to the alleged date of conception on the part of the other parties to the contests, so that he based his case on the record without taking testimony. If the interference were of such a nature that testimony must be taken, there are two more hardships to which an inventor may be put.

Forged testimony is not unknown, and as testimony is not taken before a court the effect of the attitude and character of the witnesses in forming an opinion in the minds of the judges as to whether or not the truth is being told has no influence whatever. Thus forged documents and perjury may make out a much better case when presented in the printed records than the testimony of honest inventors.

As testimony may be taken anywhere, depending upon the desires of the party in whose interest it is taken, the other party to an interference proceeding may be dragged anywhere over the face of the country to remote and inaccessible places, requiring the expenditure of a great deal of time and money in order to protect his interest properly when such testimony is being taken.

In conclusion, as my first article showed the worthlessness of many patents considered from the standpoint of whether or not they paid in dollars and cents, this article shows the hardships and injustices to which an inventor may be subjected provided his invention has value and is brought into interference. Mr. Leonard estimates that the average cost of the 20 interference proceedings that have been brought to final decision is upward of $1000 and yet except in the case of two of them, no testimony was taken. The long years of litigation and the expenditure of many thousands of dollars is sufficient to take the heart out of the average independent inventor. At the same time the inventors in the employ of a great corporation, where inventions are assigned as soon as application is made, are in the usual advantageous position given to the possessor of wealth when litigation is undertaken.

Our Patent Procedure Must Be Changed

No better phase of patent procedure can be cited than interferences to show the insufficiency and injustices of our patent sytem. Everyone really desiring the onward progress of American industries should interest himself in bringing pressure upon Congress to so modify our patent laws that the progress of science and the useful arts shall be promoted throughout our country, and that real inventors shall have some reward for their discoveries.

Snap Gages with Interchangeable Jaws *By W. H. Scheibert*

The snap gage is indispensable when interchangeability of parts is necessary in manufacturing. It has, however, a limitation that a single snap gage serves but a single size and to meet all requirements we must possess a great number, from the smallest to the largest sizes. Moreover, with hard use, the jaws of a snap gage wear away comparatively fast.

Fig. 1. A French Interchangeable Jaw Snap Gage

Therefore, the machine shops need a snap gage whose jaws are interchangeable, in some such manner as shown in the accompanying drawings, so that one and the same gage body can be used for measuring a number of different diameters or sizes.

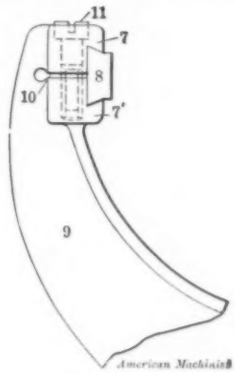


Fig. 3. Another German Interchangeable Jaw Snap Gage

Fig. 1 shows a snap gage of the Société E. Laurent u. D. Frard, Paris, France, in which the jaws can be interchanged and thus use the same gage frame for as many as 22 different measurements. This construction has, however, the disadvantage that for purposes of attaching the jaws 1 must be drilled to receive the screw 2, which holds it to its seat. A drilled and tapped jaw is subject to incurable distortions in hardening which destroy its precision. It is further to be remarked that, upon tightening the screw, in case the gage body is not drilled exactly perpendicular to the jaw, the latter receives a slight obliquity which is sufficient to prevent a precise measurement, that is to say one to 1/500 millimeters (0.00007 inch).

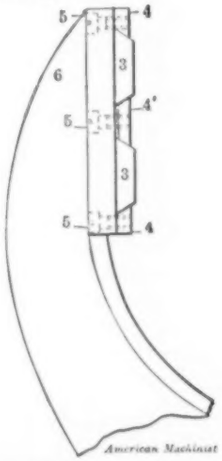


Fig. 2. A German Interchangeable Jaw Snap Gage

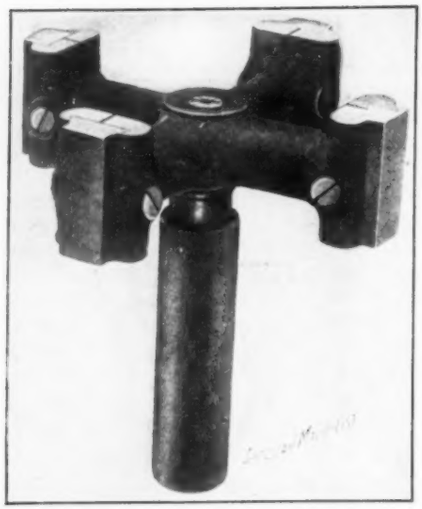


FIG. 4. A PLUG GAGE WITH JAWS OF TYPE SHOWN IN FIG. 3

Efforts have therefore been directed toward constructing snap gages whose jaws shall consist of simple plates correctly secured to their seats by other means. Two patented devices which combine easy interchangeability with great accuracy have been brought out by Ludwig Loewe & Co., Aktiengesellschaft, Berlin, Germany.

According to the construction in Fig. 2, the movable jaws 3, which are dovetailed at the lower end, are held on their seats by plates 4 4 pressed by screws 5 against the frame 6. The drawing shows one-half of a limit gage. To interchange the jaws, we need only loosen screws 5 of the middle plate, and then the two jaws can be pushed out and replaced by others.

The other design, Figs. 3 and 4, entirely dispenses with the plates 4 4, through which the jaws of the foregoing gage were pressed against the frame. Instead, the gage body has projecting lateral cheeks 7 7 which fit over the dovetail corners of the dovetail-shaped jaws 8. The gage body 9 beneath the bearing surfaces of the jaws, is provided with a slot 10 through which transversely passes a clamping screw 11, by which the parts of slotted portion of the gage body can be drawn together. Thus the dovetail cheeks 7 7 of the frame are pressed against the jaw and hold it in the right position. In this way only the screw 11 need be loosened to exchange a jaw.

Another new patent gage, Fig. 5 made by H. Weimann, of Bremerhaven, is distinguished from the foregoing design in that the changes in measurements can be made without use of a screw, or the like. For that purpose, the end of jaw portion of the snap-gage body is provided with a box-shaped case 12 which carries on the inner side a steel plate 13, serving as the measuring face of the jaw. This plate is continually pressed by a spring against a steel plate fixed to the gage body 14. When the opening of the snap gage is to

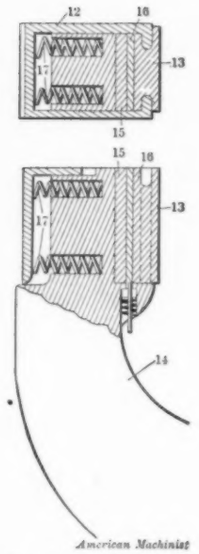


FIG. 5. A THIRD GERMAN INTERCHANGEABLE JAW SNAP GAGE

be changed there is placed between the very accurately ground plates 13 and 15 an insertion piece 16, shoving it in from the top. By the force of the springs 17 the measuring face is pressed into position.

On the inside of the snap gage is an arrangement by means of which it is easy to remove the inserted plates. This gage permits us fit it to make any desired measurement between its jaws without moving a screw or the like.

Sammy's Shop — Correspondence *By W. Osborne*

When a shop sort of grows up without malice aforethought, so to speak, that is to say, when a shop gets started just because it happened to, and then grows along bigger and bigger just because it bulges out first in one place and then in another, and the bulges have to be taken care of, it is not to be expected that it will have the symmetry and beauty of outline either in its buildings, mechanical equipment, or ways of doing business to compare with one that was premeditated.

When Sammy sees the beautiful layout of a new establishment that is to be built, and reads about it and finds that the one who did the laying out did it with the full understanding of what the shop is to be used for, how many men are to work there, how much work is to be done each day, how big an office force it is to have, and how much stock is to be carried, etc., so that he is able to show the location of each machine, the line of travel of each piece of stock through the shop, how each piece of needed information desired gets to the office at the right time and falls right in line with the rest of the information so as to make a harmonious whole, he feels very keenly the fact that his shop is not in that class.

When a shop can start in full grown, with everything perfected right at the start, it simplifies things wonderfully. It cuts out all the bewilderment and chagrin that comes from doing something that happens to come along in the first way thought of because it is an easy way to do it, and then continuing to do it that way on future occasions until suddenly it becomes apparent the way is wrong, and if not the very worst way it is at least a very bad way.

Taking this matter of letter writing, for instance. When Sammy first began running the shop and the letters began coming in he answered every one of them. From somewhere—possibly the AMERICAN MACHINIST—the idea had gotten into his head that it was the correct thing to do, and he did it. Doing this letter writing himself and also doing it out of regular working hours, it was not very long before Sammy began to cut out some of the letters. The first ones to be dropped were those that contained advertisements of things that were foreign to his business.

This was an impersonal sort of a thing because most of these letters contained only printed matter that came in an unsealed letter with a 1-cent stamp on the envelop. This gave some relief but only for a short time. It surprised Sammy to see how many people wanted to benefit him in some way, and it also surprised him to see how many people thought he should do something to benefit them even though he could not see that it would benefit him to do so.

It is altogether likely that some people thought ill of Sammy owing to the brevity of letters received from him. Many others may have thought ill of him because they did not get any. Notwithstanding all of the compressing which Sammy could do on this bulge in his shop it continued to grow beyond his personal capacity, and owing to the fact that this shop had not been planned so as to be making a "barrel" of money right along, Sammy was obliged to get some help that was not too expensive. It hurt him to do this because he had absorbed the idea from somewhere that a very high grade of talent should be used to handle the correspondence.

He went along this line far enough to find out what tried-out and branded talent considered a fair return. With a sigh he looked for cheaper help and tried how to do the best with it.

Strictly Business Mail the Most Important

There are letters which receive prompt and careful attention. These are the kind that relate directly to the business of the shop, coming from its customers, or from those whom it is a customer of. Sammy dictates the answers to these himself. Between these letters and those that go directly to the waste basket are many classes, and it is likely that many mistakes are made in disposing of them.

It is not unusual for someone to voice his objections in this paper as to the way his letters are treated by companies to whom he has had occasion to write regarding employment. This is one kind of a letter that Sammy always answers, but right here he wishes to have it understood that the companies are not the only sinners, for repeatedly he has answered letters where the writers wanted work, according to the wording of the letters, in the worst kind of ways, and yet neither the man nor a reply came back.

While he has made it a rule to answer every letter that contains an application for work, it is not a certainty that he will continue to do so, for as the business has grown so has the number of applicants increased, and the applications are not always pertinent. For instance, here is a scrawl, poorly written, badly spelled and dirty. The writer does not state any qualifications, but puts in an application for anything in sight with the statement that he has "worked at most everything and never found anything that he could not do." Yes, it must be admitted that that is an extreme case, but it differs more in degree than in principle from a large number. Sammy has never advertised for men, but he has told some of his men that he could work another machinist, who is good at small lathe work for instance, and soon applications in person and by letter would begin to come in from persons who could not be classed as machinists of any kind by any stretch of the imagination. He has wondered, even while answering such letters, whether it was right to do so. It may be a matter of surprise to some, but it would seem that there is a class of men who make it a business to hunt work. So interesting, and apparently lucrative, is this hunting that they do not stay long in any one place, but while working at one place are not trying to be valuable there, but are lining up other jobs.

The "System" Panacea

Away at the other end of the varieties of letters that come from applicants for work is the carefully planned and thought out one from the man who knows all of your troubles and shortcomings and who, for a *nominal* (it is well to know that the word "nominal," judging from experience with it, has a technical meaning that is very different from its common or everyday meaning) consideration will come in and run your business for you in a way that you never dreamed of. All you will have to do will be to see that the system is kept on the track.

Letters Re Former Employees

Another troublesome kind of letter that keeps coming to Sammy is the one that comes from the man who gets an application from one of his former workmen. While he is always willing to help along any man who has worked for him, it is not always easy to do so owing to the peculiar ideas of some of them. He does not call every man who works in a machine shop a machinist, yet men who have done the rough helping in his shop have put in applications for work as machinists, and have referred to him as to their ability When a man works for him for two months in 1907 and for three months in 1908 Sammy does not consider that he has worked for him for two years, but some men seem to so consider it. Letters asking for verification of men's statements are sometimes curious in the side light which they throw.

Several may come regarding the same man. Coming from widely separated sections of the country, and from very different classes of occupation they tend to show that the man is both industrious, in a way, and versatile.

The Trade-paper Man and the Result of His Call

As the bulging kept on, a sort of a woodshed was planned and built. One day, before it was finished, a man came rushing around and began asking questions. "How big is it? What are you going to use it for? How many men are you going to work in it? What machinery are you going to use in it?" He was told that the shed was to make room for an overflow from the shop with men and machinery all provided for, so that there wasn't any job for him or any chance to sell machinery. He wasn't working either line, but represented the advertising department of a trade paper and just had four minutes to catch the next train out of town. Away he rushed and by and by evidences of wasted talent began to roll in in the way of letters from people with wood-working machinery to sell. If Sammy had been building a world beater of a building and had sent out letters to all the builders of wood-working machinery telling of his requirements it would have been all right, but why should the possibility of a man's needing a bucksaw, some wedges and a maul bring letters beginning thus: "Kindly let us know when it will be convenient for you to have our representative call, etc." Or, "After careful consideration of your conditions we are convinced that our Universal Rig-a-majig is indispensable for your work, etc." Or, "We thank you for the opportunity of demonstrating to you that, etc." Or, "You will find that you have not made any mistake in wanting our ——— in your addition. Please let us know the size which you think will best fill your requirements and we will send our best price by return mail, etc." Or, "Having had many years of experience in fitting out uptodate plants such as you are now building, we are in position to give you the benefit, etc." Or, "Our representative expects to be in your vicinity soon and will call on you. Please do not close for any of your needs until he sees you. The benefit of his knowledge and experience will be of the utmost value to you, etc." Or, "Our Mr. ———, who is acknowledged by all to have no superior in this line, is arranging to call on you very soon. In the meantime please send us a list of your requirements, etc." Or, "If you have not fully decided just how to handle your work in your new addition let us help you. We will be pleased to do this without cost to you. Our Mr. ——— will call on you and help you to select the machinery best suited for your work and conditions. His life-long experience peculiarly fits him for doing this, etc."

The Personal Touch

These letters have the earmarks of having been written for the occasion. They have been signed with a pen or else the stamps used are very good imitations of pen work. It cost money, good money, to construct them. It would cost money to answer them, and more money to answer the answers that the answers would bring, and money is "tight."

Some of these people may think that Sammy is lacking in business courtesy, and standing in his own light. Perhaps he is, but recollect that I have only touched on the subject of the kinds of letters which come to him.

He has to get out some work even to have money enough to buy stationery and postage stamps. It also is not always an easy matter to coax money from its lair.

According to the *Mechanical World* four parts alabaster plaster and one part of finely pulverized gum arabic mixed with a cold-saturated borax solution into a thick paste, make an unequalled all-round cement for stone, glass, bone, horn, porcelain and wood, which becomes hard as marble and possesses the agreeable quality of not solidifying immediately after mixing, but only after from 24 to 30 hours.

The MAKING of a LARGE IRON CASTING

A Huge Piece of Work Handled in the Foundry by Economical Methods

BY E. F. LAKE

The molding, boring and machining of some of the large castings that are being produced at the present time is always an interesting proposition. The casting herewith described is one of the largest of its kind that has ever been made, and while no special apparatus was required for its molding in this instance, as the steel company that made it is fully equipped for large work, the job is nevertheless interesting owing to its size. This casting, as it is shown in Fig. 1, was made for the plunger chamber of the 27,000,000-gallon pump that was made for the City of Baltimore by the Bethlehem Steel Company at Bethlehem, Penn. When photographed on the car, it was being transferred from the foundry to the machine shop for machining.

For this job a complete pattern was made in two halves, as the construction was such that the company thought much better results could be obtained in this way than by using sweeps to sweep up the main body, even though it was being molded in a loam mold.

The pattern as it is being bricked up in the mold and nearing completion is shown in Fig. 3. The platform on which the loam molders are standing is located on an iron plate, the bottom of which

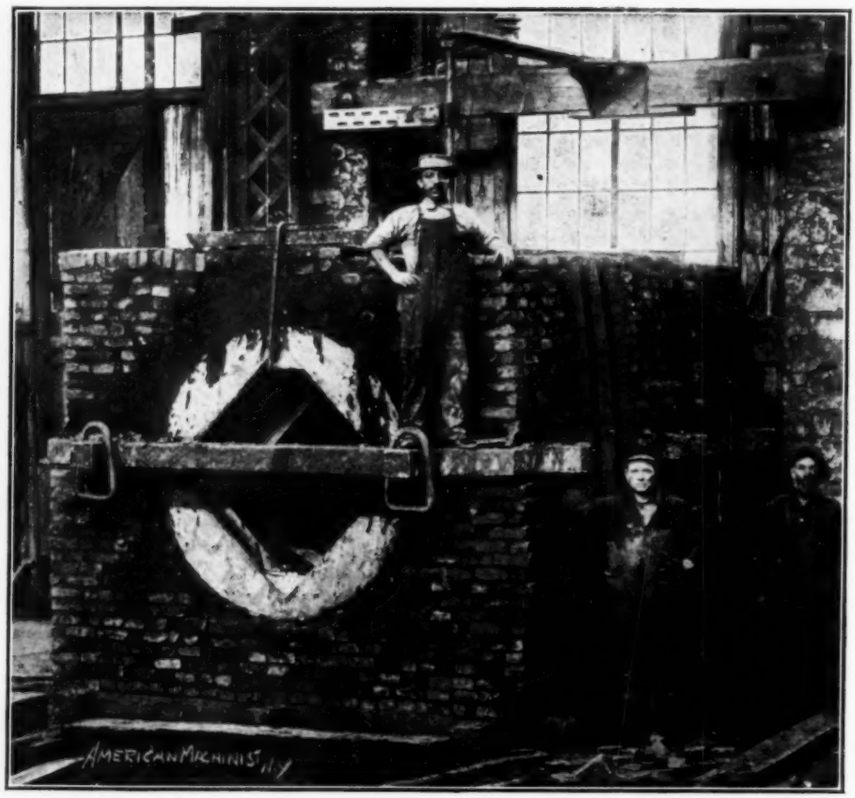


FIG. 2. THE MOLD AFTER CLOSING

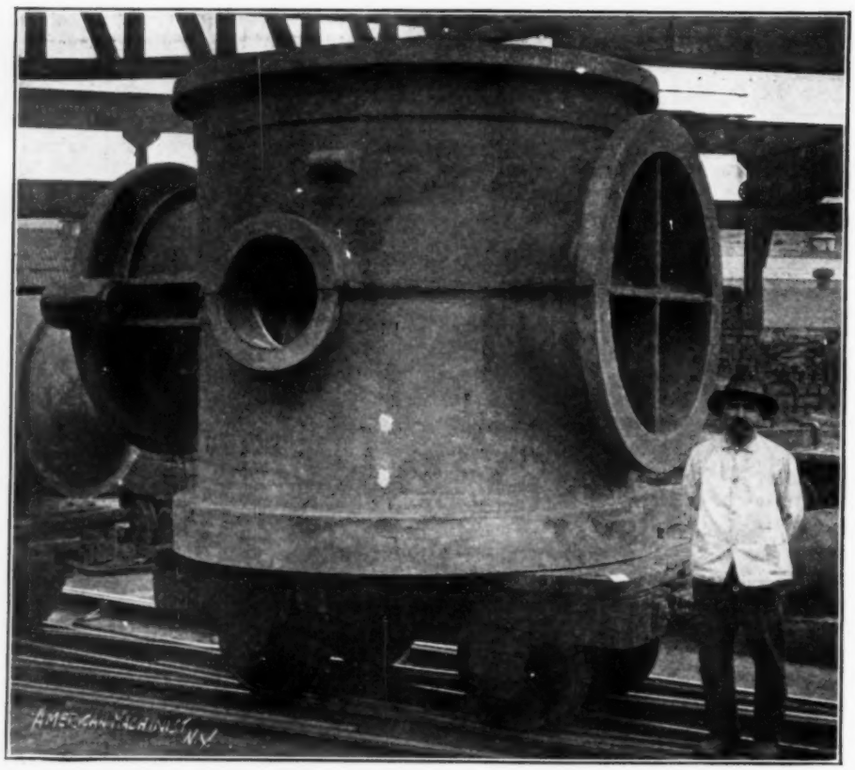


FIG. 1. PLUNGER CHAMBER OF 27,000,000-GALLON PUMP

forms the parting line in the mold; this plate supporting the brick and clay in the coke when it is lifted off for setting the cores. The drag of the mold is built up on another iron plate, located on the foundry floor, so that the entire mold can be picked up by the crane and lowered into a pit and surrounded with the floor sand for pouring. This precludes the possibility of the hot metal forcing out the sides of the mold, and thus ruining the casting.

In Fig. 2 is shown the mold after it has been entirely bricked up around the pattern, and as it is waiting for the traveling crane to lift off the cope, so the pattern can be removed and the cores set.

In Fig. 4 the mold is shown as the cope is being lowered down to be clamped to the drag, which has been lowered into a hole in the floor and bedded there by packing sand around it. As will be seen, the cores are in place in the cope. The large central core for the plunger chamber proper has been bricked up in the same manner as the outside of the mold. This is different from the usual custom of making sand cores in boxes, and results in quite a saving of material.

The wall of the central or main core

being only about 5 inches thick, it leaves the entire center open to take off the gases or act as a vent. The gases, however, do not form as freely with this kind of a core as with the sand core. The openings to the right and left of this are made by sand cores that are butted up to the central core and pasted there. To the right of the cores is seen a pipe which serves as a runner to the metal to carry it to the bottom of the mold.

The method of pouring the mold is shown in Fig. 5. In pouring this casting, which weighs 22,000 pounds, a ladle with a capacity of 30,000 pounds is used, and this is tilted on its trunnion for pouring by the geared mechanism shown. The large beams and other material on top of the mold are used to weight down the cope so it will not move or be raised by the metal poured into the mold. In the lower left-hand corner of the picture will be seen some impressions in the sand, and into these the metal left in the ladle is poured to mold them into pigs for remelting. The casting, as taken from the sand when it is cool enough, is shown in Fig. 6, with the risers, fins, sprues, runners, etc., all on. From here it is taken to the cleaning room, where the extra metal is all removed and the sand cleaned off. It is then shipped to the machine shop in the condition shown in Fig. 1. The same casting as it is being machined in the boring mill is shown in Fig. 7.

In Fig. 8 is shown one-half of a cast-iron cross, and a 45-deg. elbow that were cast in the same foundry. The elbow is 9 feet in diameter and the metal 2 inches thick.

In Fig. 9 is shown a cast-steel gear wheel that was cast by the same firm in their steel foundry. This gear had 126 teeth, and its size can be judged by the figure of the man shown in the lower left-hand corner.

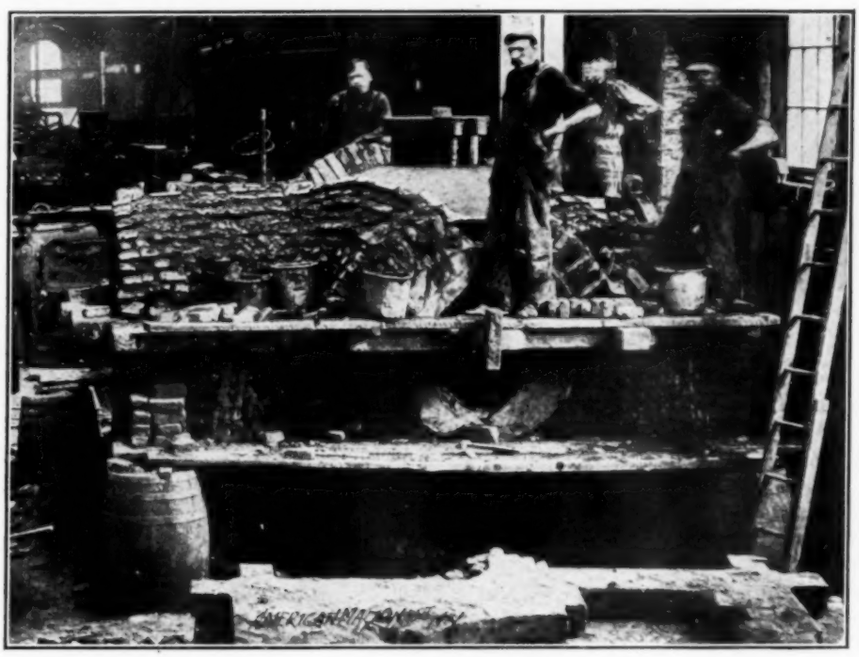


FIG. 3. BRICKING UP THE LOAM MOLD

FIG. 4. LOWERING COPE ONTO DRAG AND CORES LOCATED

Co-operative Industrial* Education

BY E. F. DUBRUL

The development of the coöperative system as first outlined by Prof. Herman Schneider, and first installed in the University of Cincinnati for the training of mechanical, electrical and chemical engineers, has aroused such a great interest, not only among the educators, but very strongly among the employers, that it is deemed advisable to make this report on that particular feature of industrial education as one of the most practical and feasible developments on this subject.

*Abstract of a supplementary report of the Committee on Industrial Education to the National Association of Manufacturers.

As mentioned in the committee report, various branches of the National Metal Trades Association are now in coöperation with institutions of different grades, as for instance at Fitchburg, Mass., with the local high schools there, and in Chicago with the Lewis Institute in that city.

If a separate and distinct trade school is found to be feasible and successful it will require a practical teacher for the trade. The danger today is that the same element who have culturized manual training into a mere dilettante performance may, as noted in the main report of your committee, demand as teachers of trades mere academicians who have added a little bench work to their other accomplishments.

A recent editorial in the AMERICAN MACHINIST makes the point that the establishment of trade schools cannot be successfully carried out for 25 years to come on account of lack of teachers of the right sort, if for no other reason. Another limitation is pressing the trade school so far in operation and that is the limitation to but very few trades, the most common being forging, foundry work, pattern making and machine-shop work. There are also a little carpentering and plumbing being done. But how is the trade school going to educate the structural iron worker, or the tentmaker,

or the ship builder, or any one of the ten thousand occupations which surely manifest impossibility of housing in a school building? The multiplication of numbers of occupations all limit the opportunities for trade-school work in such occupations, and must necessarily be done outside of a school building or not at all, in so far as the practical features are concerned. The boy who wants to be a tentmaker or a bonecutter or a buttonmaker has just as much right to demand efficient training as the boy who wants to be a machinist or patternmaker. Look at the classified index of business houses and manufactories at the back of any city directory, and tell, if you can, how trade schools can be organized to take care in the schools of all of those thousands of occupations, whose workmen have as much right to demand training in their lines as in any other. What city could afford to put in separate schools for all those occupations?

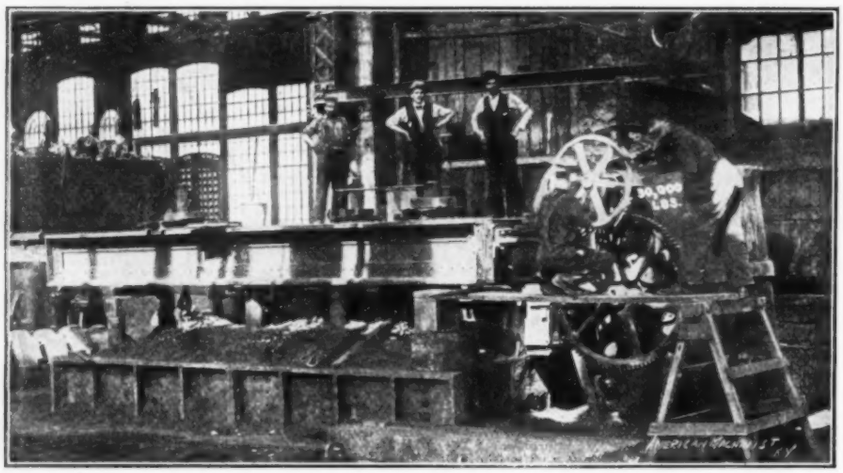


FIG. 5. POURING THE IRON INTO THE MOLD

PROVIDE INTERESTING WORK

Here is where the coöperative system comes in, and it means essentially to let the shop train the hand and the school the mind. It means that the elementary grades must develop practical and concrete problems in their arithmetic, in their geometry, in their mathematics and in their drawing. It means not giving the pupils mere exercise in mental gymnastics, but giving them live, interesting work at arithmetical problems in connection with things that they can actually see and feel. Then instead of arithmetic being a bore it will be a pleasure. A boy with a 2-foot rule, or a girl with a yard-long tape line will learn more arithmetic, fractions, mensuration, division, proportion and every other part of that science in a few weeks than they now learn in as many months, if not in years, by means of abstract-number problems.

A simple set of weights and measures should be in the equipment of every school house, if not of every school room.

Under the coöperative system part-time training and division of time is to be suited to the particular circumstances, whether alternate days, half days, or weeks. It puts the training of the hand where it always has been, and where it probably will be for many years to come, if not for all time—in the shop or on the job. It keeps the training of the mind where it properly is now, and should always be—in the school room.

In the United States there are over 18,000,000 children in the public schools. Over 17,000,000 drop school at the minimum age permitted by law in the various States and go into agricultural, commercial and industrial life without having received one iota of industrial training worthy of the name. If placed in a line giving 1 foot space to each child, the line would reach from the upper end of Maine to the lower end of California. Those children that go through the high schools would reach across the State of California, but the rest of the line from Maine's farthest corner to California's eastern border go into active life at about the age of 15 years.

Investigators of this phase of education find that almost any man considers his own business more difficult to learn than any other, and when aroused to the problem wants the trade school to teach the children who go into the field of work he knows best. The prospect of teaching all lines with separate equipment for each different occupation in any city immediately shows such a top-heavy organization and such an excessive requirement for buildings and equipment that the imagination is staggered. In many lines the equipment becomes obsolete in from 7 to 10 years. To properly teach the trades in schools means the remodeling of equipment at least once in 10 years. Some say that only the more important trades should be taught. Then

First: Who shall decide which are these trades and how shall the public support be obtained from all sources for those few trades?

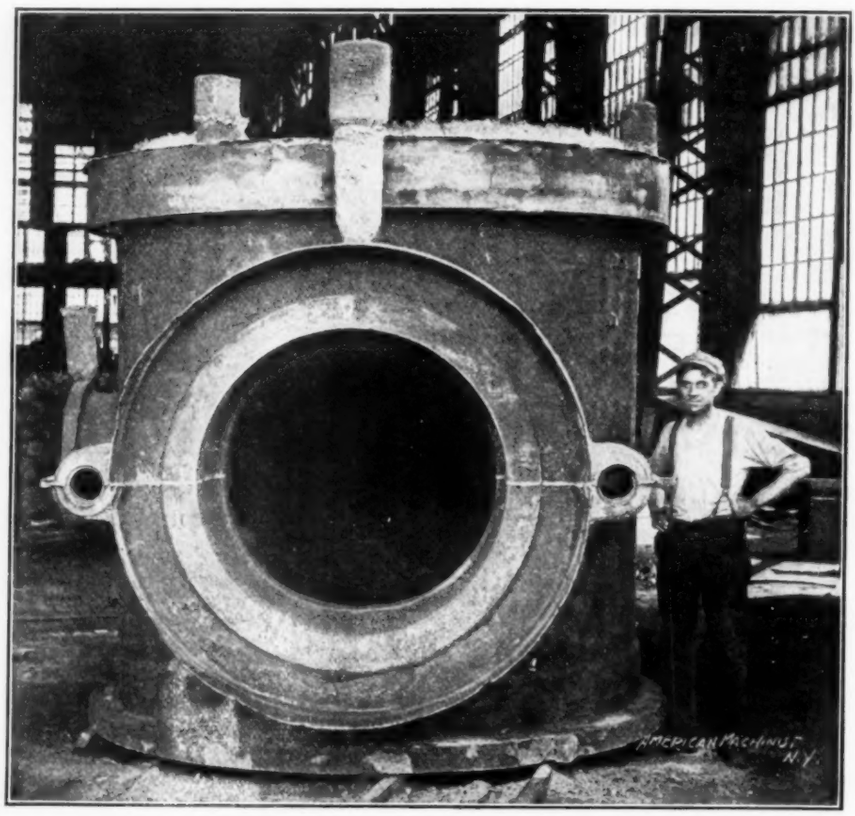


FIG. 6. THE CASTING AS IT WAS LIFTED FROM THE MOLD

Second: Are the other trades to be neglected, leaving the desires of the children or their necessities entirely out of the question? or

Third: Shall only a few be educated in the more important trades and the rest allowed to shift for themselves as heretofore?

Children Are Forced to Go to Work Early in Life

Then what about the individual taxpayer whose boy or girl wants to take a trade that your boy or girl does not want and which the schools do not teach? Have they not the equal right to get the kind of education that will be most valuable to them and in conformity to their desires? Does not after all a thorough exposition of the scope of the problem point inevitably to the coöperative system, which is easily adaptable at slight expense of money and at heavier expense of time and effort on the part of the educators?

Under present conditions children leave school to go into industries or stores, and there is absolutely no connection between the school and the shop. Yet it is not because they want to go to work, but because they have to. The upper grades of our schools are carried on for those who are so fortunate as to not be compelled to work for a living in their early ages.

By a little effort the public-school system can coöperate with the factories, stores, etc., and continue training the young people after they have found their work. The details are easily supplied when the principle is once grasped and the details will vary with different cases in different localities. The system is economic. In our Engineering College at Cincinnati we can teach twice the number of students at two-thirds the cost of the old system and turn out practical engineers which the old system could not do. The coöperative plan will save the money to use for brains in paying good salaries to good teachers that would otherwise be sunk in physical equipment to be replaced every 10 years.

The student earns while learning. Under the old college system, or under the trade-school system, he earns practically nothing until he has completed his trade education. Many a child could afford to continue in school under the coöperative system who is now compelled to take a low-grade, poorly paid, unskilled position without any future prospects, either in money or acquirement of skill. The coöperative system does not apply only to factories or mechanical trades. It will apply to the tailor, baker, butcher, builder, or any other trade where the mechanical equipment or natural conditions are different from mechanically equipped factories.

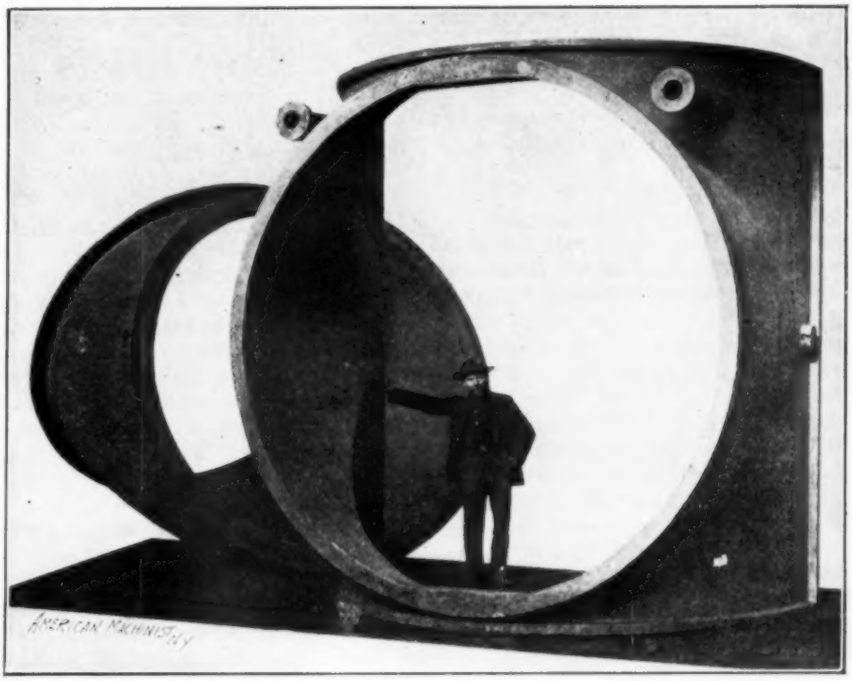


Fig. 8. Cast-iron Cross and a 45-degree Elbow

Fig. 9. Large Cast-steel Gear Wheel

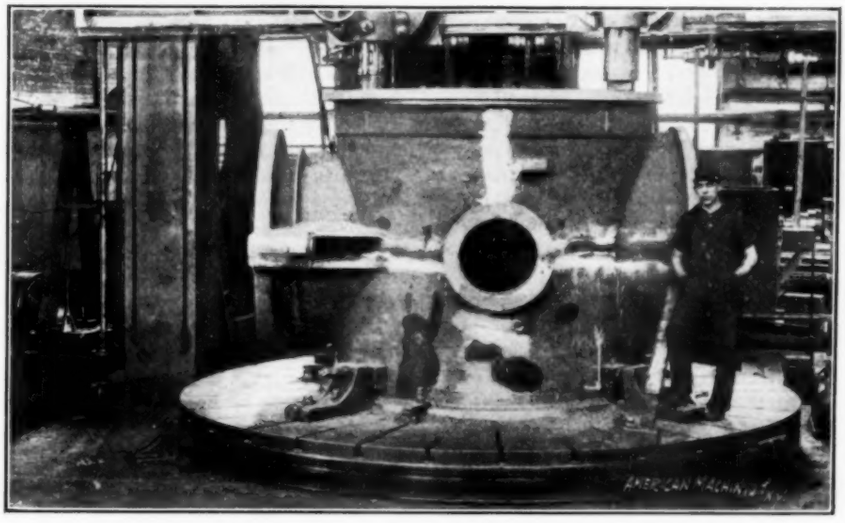


Fig. 7. The Casting Being Machined in the Boring Mill

Employers and School Authorities Work in Harmony

The grade-school principal follows the boy when he leaves school and finds out what he is doing. He consults the parents and the employer and the boy's future is seriously considered. The employer indicates what lines of instruction would benefit the boys or girls in his factory, and the school authorities work out a course along the lines found desirable. After a child has found work for which it has no aptitude, an attempt is made by the principal to find out just what the child is best fitted for. As one man expressed it, "Under the coöperative system the grade-school principal pays less attention to biology and much more to the boy."

Another feature of the work is coördination between the school and the shop. The instructor in this branch is one acquainted with shop practice. He spends part of the time in the shops and part time in the school. It is his business to observe the students at their work—to make observations as to the methods of the work—the shop system, and any other matter of interest, noting particularly the every-day application of the various sciences, such as mathematics, physics, chemistry, etc. He then points out in class the principles as exemplified in the work.

A certain department store in New York City is about to put in the coöperative course, if it is not already installed. In this case, where the clerks are not very busy until 10 o'clock in the morning, the store can easily get along with one-half of its clerks, say from 8 to 10, one-half of them receiving instruction this week during those two hours while the other section is working, and the following week they change about. In this case the students do not go to school, but the teachers go to the stores; another example of both coöperation and coördination. It is easier to transport 20 teachers than a large number of student clerks. Some of the large rooms, as carpet and lace rooms, are being used as school rooms, the chairs being removed at 10 o'clock, but sufficient space being reserved for any business that may be necessary up to that time. Those salespeople are taught among other things psychology of salesmanship, and are given as much knowledge as possible of the things they are selling. They also receive a certain amount of general education.

The shoe department, for instance, gets their shoe manufacturer to send an expert demonstrator, who explains to the clerks all operations in shoemaking and the elements that make up the different qualities and costs of shoes. The shoe manufacturer secures from his tanner the services of a leather expert, who explains to the department-store clerks the differences in leather, the methods of preparation and the reason for using different leathers in the different parts of a shoe. Any manufacturer will gladly go into a scheme of this sort for the good it does his business. It makes the salespeople more efficient and benefits the manufacturer as well as the merchant.

The Plan Disarms Criticism

Some people have stated that it is impossible to work two sets of students in alternate weeks. We can only point to the fact that it is being done and has been successfully done now for three years in Cincinnati, and wherever school authorities have made an attempt they have found in fact the employers ready to coöperate to give the system a start. Once started, there is no stopping it. It only takes a little good will, patience and serious effort.

This system cuts the ground from under the feet of those unionists who oppose trade schools. We may well sympathize with machinists who find trade schools training only machinists in their belief that their trade would be overcrowded when other trades are clamoring for help, but what unionist could oppose the idea that takes a young person who had already obtained a foothold in a trade and gives that person instruction in a school that would make for greater efficiency? No opposition to the coöperative system has developed anywhere. In fact, in Fitchburg the plans were made during a severe strike, and the unions there when they fully realized the benefits of the system as applying to all children in their trade, withdrew what opposition had been prevalent.

In Chicago there is an agreement between the school authorities, the building-trades unions and master builders, whereby the apprentices in building trades are compelled to attend school during the winter months when the building business is slack.

This is the coöperative system with a variation in detail to meet conditions. A survey of the field shows that the coöperative system for the general public is the only practical system possible of quick installation and possible of quick results at this present time.

The Solvay Process Company's Experience

The Solvay Process Company at Syracuse, N. Y., after an attempt at a trade school along the ordinary line of trade schools found the students on graduation all desirous of white collar jobs and expecting roll-top desk positions on receipt of their diplomas. Try as they would, they could not make mechanics, and the school was discontinued, and after a long search for the proper means of training men for real work the Cincinnati coöperative scheme was proposed to the management and adopted. The Solvay Process school now trains molders, riggers, carpenters, patternmakers, boilermakers, and some other trades necessary to the work of that company. The students are working in alternate weeks in shop and school and when thoroughly organized and beyond the danger of academic meddling it is proposed to turn the company's school over to the public schools.

The University of Wisconsin and the Massachusetts Institute of Technology have adopted the Schneider plan for engineering education and through the University of Wisconsin the system will no doubt spread all over that State in all grades of schools. Other towns have the matter under consideration for the lower grades, for instance, Chattanooga, Tenn., and Yonkers, N. Y.

In conclusion, it is desirable to state that the main object of this supplemental report is to impress upon the membership of our association the fact that the coöperative scheme is feasible and economical. It is well worth the interest of any manufacturer to study its features and to agitate for its adoption in his own community as the one plan today promising immediate results, if indeed it is not the only plan likely of adoption, for years to come.

Heat Treatment to Reduce Size of Hole

By H. D. Chapman

When a hole has been drilled or bored too large in a ring gage or a bushing of any size, a good method of reducing it to the required size is to heat the piece red hot; keep the hole perpendicular to the surface of the water and dip the piece half way in the water. The lower half will become cool and shrink and the part which is not in the water will still be red hot, and shrink as it cools. When cooled off, one-half of the piece is then smaller than the other.

Heat the metal red hot again and repeat the operation, but cool the opposite side in the water. If the hole is then found to be too large, repeat the operation until it is brought down to the required size.

This method is a practical one for tool and machine steel and a hole can be reduced as much as 0.03 to 0.05 of an inch by repeated operations. If a hole is found too large in a piece of brass it can be reduced in the same manner by dipping in strong borax water.

Shipbuilding in the United States

According to the annual report of the Commissioner of Navigation, the total tonnage of shipping constructed in the United States for the fiscal year ending June 30, 1909, was the smallest since 1898. The construction for 1908, which comprised 1457 vessels, aggregating 614,216 gross tons, was the largest ever constructed. The decline, therefore, to 1247 vessels of only 238,090 gross tons in 1909 is very marked. This sharp decline, says the *International Marine Engineering*, was, of course, not unexpected, on account of the general business depression throughout the world. Other countries suffered in this respect as well as the United States, for shipbuilding in the United Kingdom dropped from 1,580,000 tons in the calendar year 1907 to 914,000 tons in 1908. During the past few months shipbuilding has revived somewhat, and it is estimated that both in the United States and abroad the tonnage built during the current fiscal year will approach the normal output.

COMPOUND AIR COMPRESSOR CYLINDER RATIOS

Best Ratio for Economy is Equal Work

BY SNOWDEN B. REDFIELD

Mechanical engineers seem never to tire of the discussion of the most suitable cylinder ratios for steam engines under various conditions of compounding. Even after an engine has been carefully designed so that equal work will be performed in each of the various cylinders, it is more than likely that the operating engineer, who has his own ideas on the subject, will so adjust the valve gear that the balance of work will be disturbed and he will point with pride to the fact that at peak load his indicator diagrams are bigger than they were before the valve gear was changed, or else that with normal load the governor is revolving in a higher plane than before, indicating that less steam is being used. The question does not seem to be settled as yet, and probably never will be, so long as different men continue to hold different opinions.

This unsettled state of affairs for steam engines has sometimes been dragged into the field of air compression by these enthusiasts, and when the air-compressor designer states that the minimum work for air compression will be required when the work in the two air cylinders of a compound compressor is alike, the enthusiast immediately refutes this statement with an argument and description of what he has done with the valve gear of a steam engine to alter the ratio of expansion in the cylinders.

Not Comparable to Steam Cylinders

Such arguments are utterly useless, because the subject of compound air-compressing cylinders is not related to compound steam engines, as the conditions in the two cases are entirely different. Numerous excuses are given for the compounding of steam engines, and there are those advocates of the single-cylinder steam engine, who state that if given equal conditions, there is no advantage to be obtained by compounding a steam engine at all.

With an air compressor, however, there is an actual saving in the work performed to compress a given quantity of air to a given pressure when this is accomplished in two or more stages and suitable construction is provided for properly cooling the air between the stages. This also assumes that sufficient valve area is given to the compressing cylinders to allow the air to come into and go out of the cylinders without undue throttling.

Saving due to stage compression in an air compressor is due solely to the possibility of cooling the air between the several stages. If there is no cooling between the stages, there is no saving in the power required to compress and the work might just as well be done in one cylinder; in fact it would be more economical under those circumstances to do the work in one cylinder rather than in two.

Ratio for Equal Work

On the right of the accompanying chart will be found three theoretical adiabatic indicator diagrams of a compound air compressor pumping from atmosphere to 100 pounds gage pressure with various cylinder ratios. In the case of the middle set of diagrams the cylinder ratio is made 2.794, this being the square root of the total ratio of compression, which is 114.7 divided by 14.7 or 7.8. Under perfect adiabatic conditions, if the ratio of the cylinders of a compound compressor is equal to the square root of the total ratio of compression, the ratio of compression in each of the cylinders will be the same as the cylinder ratio, and the work in the two cylinders will be alike. Furthermore, under such conditions, it is a fact that the total horsepower necessary to be developed by the compressor to deliver the air to the given pressure will be a minimum. In other words the saving by compounding will be a maximum.

Noting the central indicator diagram at the right of the chart, it will be seen that compression is carried up along the adiabatic line from atmosphere to the intercooler pressure which is 26.4 pounds gage. This pressure is obtained by multiplying the absolute initial pressure, 14.7, by the cylinder ratio, giving the absolute intercooler pressure. Subtracting 14.7 from this gives the gage pressure. This is due to the fact that all the air entering the low-pressure cylinder must go into the high-pressure cylinder after cooling to the original temperature and at equal temperature the absolute pressures are inversely proportional to the volumes. At this point the air passes out of the low-pressure cylinder and into the intercooler, which is supposed to be provided with sufficient cooling surface and sufficient cooling water to reduce the temperature of the air, which by the way, would have been about 240 degrees Fahrenheit, down to the original temperature of the atmosphere. When the temperature of this air has been reduced to that of the atmosphere, its volume will also have been reduced as is shown by the shaded area of the indicator diagram under consideration. This reduction in the volume of the air is exactly where the saving of power takes place by compounding the compression.

Compression in the high-pressure cylinder follows up the adiabatic line as shown, until it eventually meets the 100-pounds pressure line, when the air is discharged from the cylinder. In the central diagram, the shaded area below the 26.4 pounds pressure line represents the work done in the low-pressure cylinder, and the shaded area above this line represents the work done in the high-pressure cylinder. Under the imposed conditions these two areas will be exactly alike. That portion of the diagram which is unshaded represents the amount of work which is saved by compounding over and above what would have to be done if the compression were in a single stage. If the compression were in a single stage the full area would represent the work that would have to be done by the compressor.

Low Cylinder Ratios

As the statement has been made that the conditions represented in the central indicator diagram are such as will give minimum total work, it follows that with any other cylinder ratio the work done by the compressor upon the air will be greater than this. Glance next at the lower indicator diagram shown in the chart. In this case the cylinder ratio is made 1½, in other words the low-pressure cylinder has only 1½ times the volume of the high-pressure cylinder. It will then be found that the inter-cooler pressure will be equal to 7.3 pounds gage, and the work done in the low-pressure cylinder will be represented by the shaded area under this line. After passing the air out of the low-pressure cylinder and into the intercooler, the air is supposed to be reduced again to the original atmospheric temperature, and in so doing, as before, the volume of the air will be reduced. Now, however, since the ratio of compression in the low-pressure cylinder, which is the same as the cylinder ratio, in a theoretical case, is only 1½ instead of, as in the previous case, 2.794, it follows that the temperature of the air just before leaving the low-pressure cylinder is not so high as in the first case considered. The temperature being already low, there is not so great a reduction in temperature possible in the intercooler and consequently there is not so much reduction in volume by the process of intercooling. The result of this is perfectly logical, that is, that there

is not so much saving in compounding in the case under consideration as there was in the first case, when the work was equal in the two stages.

As graphically illustrated in the lower diagram, compression in the high-pressure cylinder follows up the adiabatic compression line until it finally reaches 100 pounds pressure. The work performed in the high-pressure cylinder is then represented by the upper shaded area. As before, the work saved by compounding is the unshaded portion of the diagram, but it is easy to see that this unshaded portion is very much less than the unshaded portion of the middle diagram, or in other words, the saving in work is less than before, as surmised from the temperature considerations.

Suppose now that this condition were exaggerated still further, the cylinder ratio being made, say, 1¼. This would bring the intercooler pressure still lower, causing the compression in the high-pressure cylinder to begin nearer the right-hand end of the diagram. The unshaded portion, representing the saving, would be still narrower, until finally, with a cylinder ratio of unity, the intercooler pressure would be atmospheric and all of the work would be performed in the high-pressure cylinder. The compression would then be single stage and the unshaded portion representing saving, would have disappeared entirely. Under these circumstances, the work required to compress the air would be equal to that which would be required to compress it in a single cylinder from atmosphere to 100 pounds pressure.

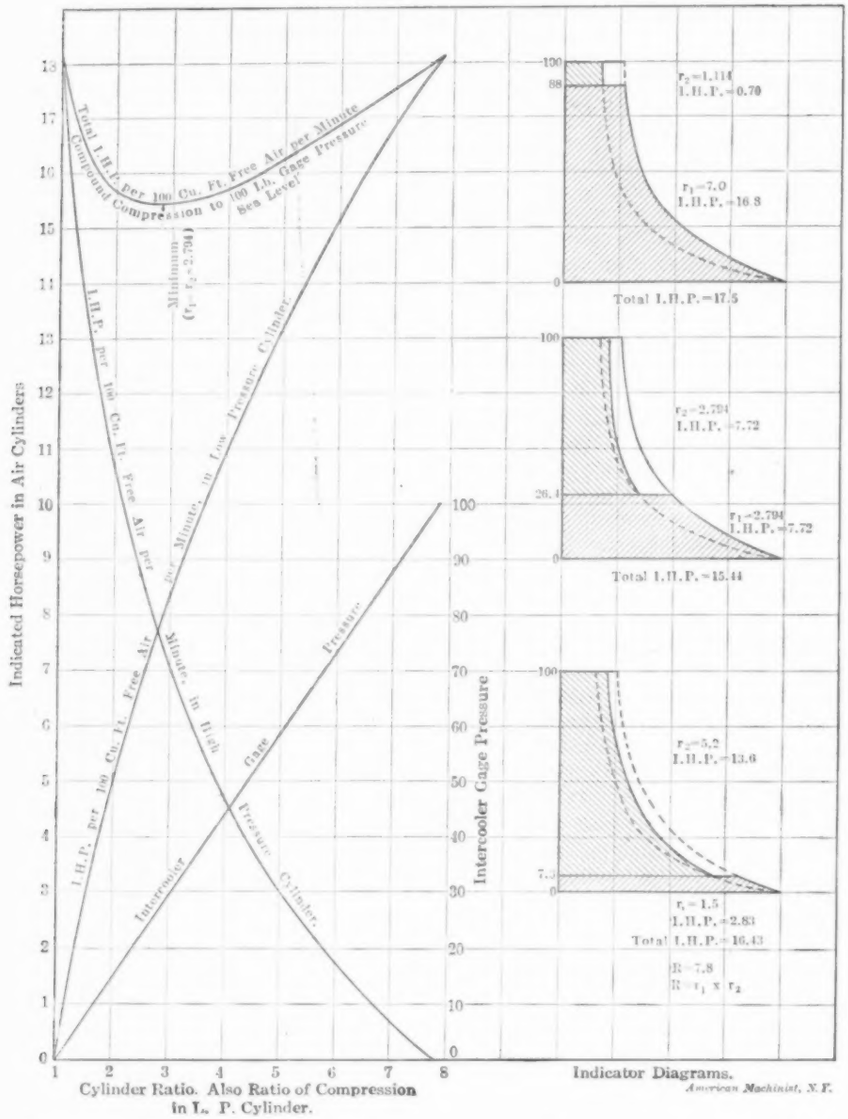


DIAGRAM SHOWING EFFECT OF VARIOUS CYLINDER RATIOS FOR COMPOUND AIR COMPRESSION TO 100 POUNDS PRESSURE

HIGH-CYLINDER RATIOS

In the top diagram in the chart the other extreme will be noted. In this case the cylinder ratio is made 7 to 1, in other words, the low-pressure cylinder volume is 7 times as great as that of the high-pressure cylinder. In this case, as is easily seen by noting the shaded area, the vast preponderance of work is done in the low-pressure cylinder and the intercooler pressure is at 88 pounds. The shaded area above this line represents the work done in the high-pressure cylinder and this will be seen to be very small indeed, compared to that done in the low-pressure cylinder. Furthermore, the unshaded area representing the saving in work due to compounding, is very much smaller than it is in the central set of diagrams showing again that the economy is not so great as in the case first considered, when equal work in the two stages was assumed.

This condition again could be exaggerated still further, making the cylinder ratio, say 7¼. In this case the intercooler pressure would be still higher, the work done in the high-pressure cylinder would be still less and the unshaded area representing the saving, would be further decreased until as a final condition, this saving would entirely disappear and all of the work would be performed in the low-pressure cylinder. This work would again be the same as if the compression were single stage as performed by a single-cylinder compressor.

VARYING THE RATIO

As will be seen by the three sets of indicator diagrams, the horsepower in the two cylinders varies with the cylinder ratio and the total horsepower performed also varies, this being the sum of the two. Of course, other cylinder ratios than those shown in the diagrams could be figured out and the total horsepower in the different cases noted. In fact, this has been done and the results are plotted graphically at the left side of the accompanying chart. At the bottom of this set of curves, there are marked the various cylinder ratios, or the number of times the volume of the low-pressure cylinder is greater than that of the high-pressure cylinder. This ratio is carried out from unity, where the two cylinders would be the same size, all the way up to a final cylinder ratio of 7.8, this being the total ratio of compression for compressing air from atmosphere to 100 pounds gage pressure at sea level.

As these ratios increase, it will be found by noting the lines showing the horsepower of the two cylinders, that the indicated horsepower in the low-pressure cylinder is increasing from 0 with a cylinder ratio of unity, to a maximum of 18.1 with a cylinder ratio of 7.8. At the same time that this increase in power is occurring in the low-pressure cylinder, a decrease is occurring in the horsepower of the high-pressure cylinder. With a cylinder ratio of unity all the work would be performed in the high-pressure cylinder, this amounting to 18.1 indicated horsepower and dropping off according

to the curve until, with a cylinder ratio of 7.8, it finally reaches zero. In each cylinder the horsepower is figured for 100 cubic feet of actual free air at atmospheric pressure, per minute.

Minimum Horsepower

Examining the upper curve marked "Total indicated horsepower per hundred cubic feet of free air per minute." etc., it will be found that the minimum total horsepower occurs for 100 pounds final pressure when the cylinder ratio is 2.794 and the ratio of compression in each of the two cylinders is alike and also equal to 2.794. At this point the horsepower in the two cylinders is alike and equal to 7.72, the total horsepower, of course, being 15.44 per hundred cubic feet of free air per minute. On each side of this minimum point the horsepower increases up to that required for single-stage compression to 100 pounds pressure, namely 18.1 horsepower per hundred cubic feet of free air per minute.

As a matter of fact, the curve of total horsepower is so very nearly flat over a considerable range of cylinder ratios, that a good deal of variation is possible without increasing the total horsepower performed to any noticeable extent. A glance at the upper curve in the chart will show that for cylinder ratios varying from about 2 to 3.5, the total horsepower is practically the same. However, this variation of cylinder ratio considerably unbalances the machine, so that with a cylinder ratio of 2, while the work done in the low-pressure cylinder is only 5 horsepower per 100 cubic feet of free air per minute, that performed in the high-pressure cylinder at this ratio is about 10.6. With a cylinder ratio of 3.5, the work performed in the low-pressure cylinder is about 9.8, and that in the high-pressure cylinder only 5.8. In each of these cases the total horsepower is the same: 15.6.

As long as the total horsepower is only slightly affected, the question may then be raised; what difference does it make if the machine is unbalanced? The only difference is this; that in designing a compressor it is to be presumed that the bearing surfaces are calculated for certain total pressures per square inch of projected bearing area to give satisfactory lubrication and cool running. If then 100 per cent. more work is thrown upon one side of the machine than upon the other side, the machine is not running under favorable conditions, and that side which is doing the most work is more than likely to develop a hot bearing unless the bearings and pins are constructed accordingly. In this case either one side is overloaded and the other underloaded or else the machine must be made "lop sided," which can hardly be considered economical design.

So far a pressure of 100 pounds and compound compression only, have been considered, but all the arguments hold good for any other pressure and for any number of stages of compression. For three stages, the cylinder ratios would be the cube root of the total ratio of compression. For four stages the ratios would be the fourth root of the total ratio.

Practical Considerations

All of this is theoretical, but the effect of practical working is simply to add a small quantity to the horsepower developed in each cylinder, and consequently to the total horsepower, this additional work being caused by the necessity of forcing the air into and out of the cylinders through the valve passages. In ordinary working, however, it is found that perfect intercooling is never attainable. In other words the air passing through the intercooler is never reduced entirely to the original atmospheric temperature. The effect of this is to slightly raise the intercooler pressure above that which would be obtained if theoretical conditions could be secured.

Slight raising of the intercooler pressure will, of course, throw more work on the low-pressure cylinder, decreasing that done in the high pressure and slightly increasing the total work of the two cylinders. In order to obviate this condition, it is considered good practice in compound air compressor design to make the cylinder ratio a little less than the theoretical ratio for equal work, so as to give an intercooler pressure, which theoretically would be about 3 or 4 pounds less than that which equal work would dictate. This applies also to three, four, or any number of stages, the pressure allowance increasing with their number. It then happens with practical conditions and imperfect intercooling, that the intercooler pressure will be raised above that which would be calculated from the cylinder ratio, approaching more nearly to theoretical conditions, giving a minimum horsepower, a more balanced compressor and consequently a more economical design from every standpoint.

Mistakes Made by Draftsmen *By G. E. Flannagan*

Some draftsmen, experienced and fairly competent along certain lines of work, utterly fail to grasp the principles of the most ordinary and frequently used mechanical devices. As an instance of this failing, take the case of a rod keyed into a hub as shown in Fig. 1. Many draftsmen will design the rod with a taper end, and form a shoulder upon it also, failing to appreciate the fact that it is a matter of extreme difficulty to produce such a fit as will develop the benefit of both the taper and the shoulder at the same time. In the great majority of cases either the taper or the shoulder alone will give satisfaction if well constructed, and choice should be made of the form most easily produced, usually the shouldered rod end.

It is in the detail of the key-slot, however, that the fault is most apparent, it being by no means uncommon for the draftsman to show it as in Fig. 2, the key tapering on each side in both the rod and the hub, and without clearance in either; serving indeed to hold the parts in place but having no effect in drawing them together to form a tight joint. Again, men who have progressed beyond this stage and learned that it is only necessary to have a taper on one side and give the clearance required to allow the parts to draw together still trouble themselves to

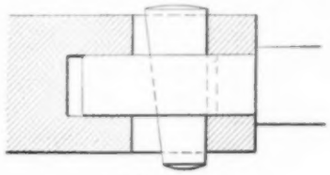


FIG. 1

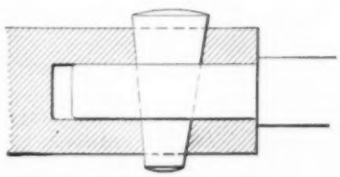


FIG. 2

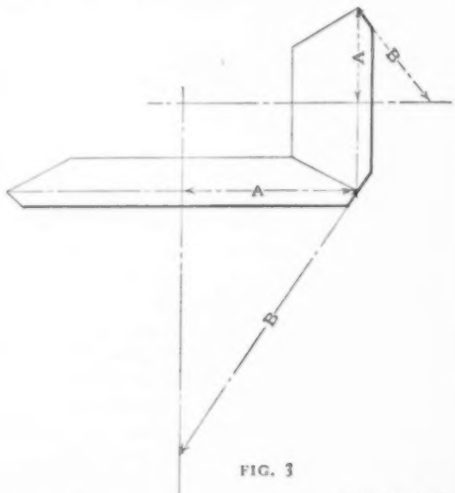


FIG. 3

American Machinist

MISTAKES MADE BY DRAFTSMEN

calculate dimensions for a tapered slot in the hub, where it is entirely unnecessary, corresponding to that of the key. As will be noted in Fig. 1 the slot in the hub may have parallel sides, the only requisite being that it is wide enough to admit the key, and that the bearing side of it is located correctly. One side of the key is made tapering as is also one side of the slot in the rod, and there are three places upon which the key bears and three where clearance is required, as shown in Fig. 1.

A surprisingly large number of men who are familiar with the design of spur gears still develop the teeth of bevel wheels incorrectly, using radius *A*, Fig. 3, in place of *B* for drawing the pitch line in the development of the teeth, and many of them, even after having learned that this is incorrect, continue to calculate the tooth outline curves as though for a wheel having a number of teeth corresponding to a radius *A*, in place of the cone radius *B*.

The size of ordinary iron or steel pipe is not the inside diameter nor yet the outside diameter. In the larger sizes it is approximately the former, while for the smaller sizes it is nearer to the latter, but it is never exactly either; and this is a fact which is often found to surprise men who should be perfectly familiar with it, and also with the other fact that extra strong pipe is the same outside diameter as common but has thicker walls and smaller inside diameter, and that double extra strong is still smaller inside. The pipe above referred to is what is in general use and is technically known as "I. D.," or inside-diameter pipe and is made in sizes from ⅛ inch to 12 inches. In larger sizes, from 12 to 30 inches, there is what is known as "O. D.," or outside-diameter pipe in which the outside diameter is as near to the given size as the conditions of manufacture will permit.

Tables of pipe dimensions are published in various handbooks, giving the thickness in thousandths of an inch, but the pipe as furnished will frequently fall 5 per cent. or more below what the tables call for. Where this amount of variation is objected to "full-weight pipe" should be specified, which is made from selected plates and is thus distinguished from the ordinary merchant or commercial pipe. When ordering O. D. pipe the thickness required should be mentioned and it should not be less than ⅜ inch if the pipe is to be threaded. Less than this has not been found generally satisfactory.

Turning Driving Axle Journals *By E. N. Owen*

Believing the results obtained in the Los Angeles shops of the Southern Pacific Company should be of value to others, I give some details of what has been accomplished there.

At the time of investigating methods used and the results of this work, it was found that only three journals were being turned and burnished in nine hours. At present they can turn and burnish six in nine hours with ease, as the result of several changes.

The old wheel lathe was found to be running at a little over four revolutions per minute. It was speeded to 22 revolutions or about five times faster, being a belt-driven machine. The man in immediate charge of the work then hit upon the plan of taking out the intermediate gear, between the cone gear and the main gear on the shaft which drives the face plates, and at first a belt was run over the gear teeth on the cone gear and large gear with very little if any damage to the belt. Afterward bands were made and put over both gears.

Being an old machine it was found after the machine was speeded up so much, there was a great deal of chatter on account of badly worn pinions on the shaft which drove the faceplates.

To overcome this fiber gear pinions were made, new bushings were put in the main shaft boxes and when properly lined in position and all adjustments made, the machine was found to run almost noiselessly and with very little chatter.

The burnishing tool was then made as illustrated at page 462, Volume 32, Part 2, of your paper, and all was now ready for business.

Six journals can be gotten now easily and sometimes one is finished in an hour.

Counter weights must be used on the driver to overcome the counter balance on the other, but this can be quickly bolted into place. I do not think there is another locomotive shop anywhere getting any better results.

Locomotive journal turning is a very cumbersome piece of work and when one goes through the number of changes necessary to get a journal in an hour, he is getting fairly good results. Above results were obtained through the cooperation of G. H. Goodwin, general shop foreman; C. J. Herbeker, machine foreman.

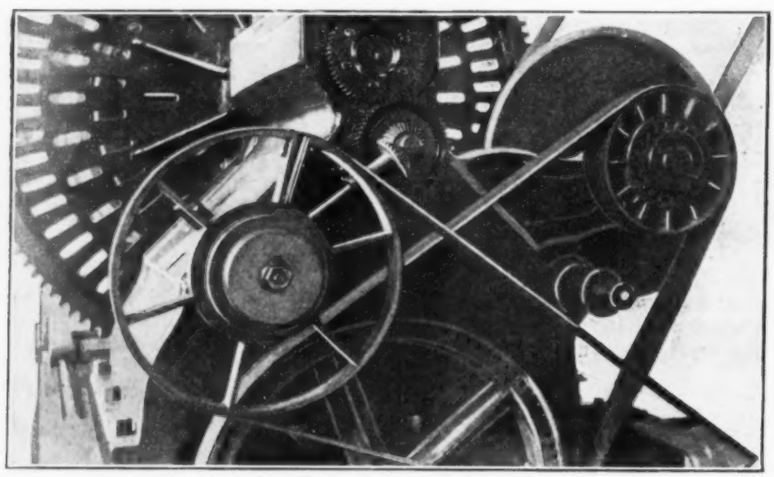


FIG. 1. END OF LATHE WITH BELT OVER GEARS.

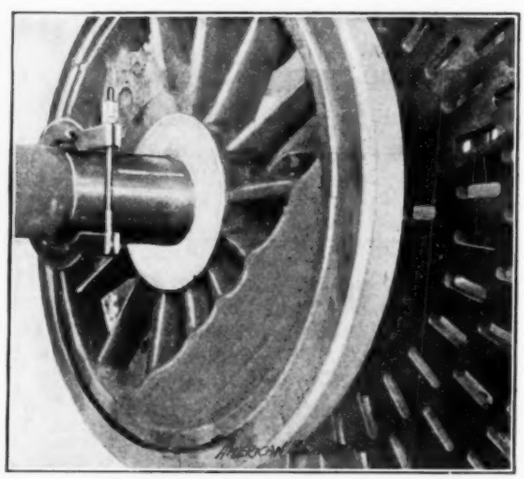


FIG. 2. BURNISHING THE JOURNALS

From a series of tests made on run-of-mine and briquetted coal in a locomotive boiler conducted by the United States Geological Survey it has been found that at low rates of working, run-of-mine coal gives a higher equivalent evaporation than briquets; at medium rates there is little difference; at high rates briquets do considerably better, and there seems to be little difference between the large and small briquets.

A New English Woodworker

By I. W. Chubb

A woodworking machine for pattern-makers and others which, as the result of considerable experience, has lately been introduced by the firm of R. S. Allan & Co., Gateshead-on-Tyne, England, is divided into two parts, each self-contained and carried on a single base-plate. Figs. 1 and 2 illustrate this well. At one end of the bedplate is a table for the machine-steel cutter spindle with cone bearings. This runs on a horizontal axis and is belt driven at the outer end. The inner end carries chucks for the cutters, a variety of which are supplied with the machine. It also bears a loose thimble, on the face of which a groove is formed for the shoulders of the cutters to fit into, to prevent their slipping or twisting off, a number of which are of Sheffield high-speed steel. When in position the cutter is secured by a hardened steel screw that holds both thimble and cutter. Thus the latter is easily secured and released. Various forms of extension bars, used for cutting the inside of cutter boxes, flanges, etc., can be screwed into the chuck and the end of the spindle, and are locked by the set screw.

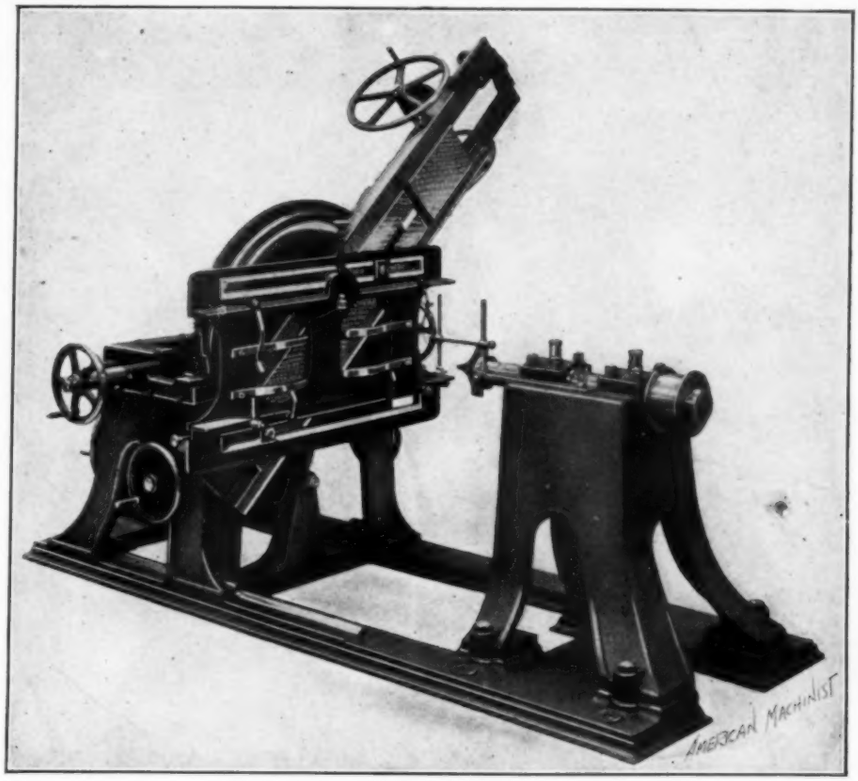
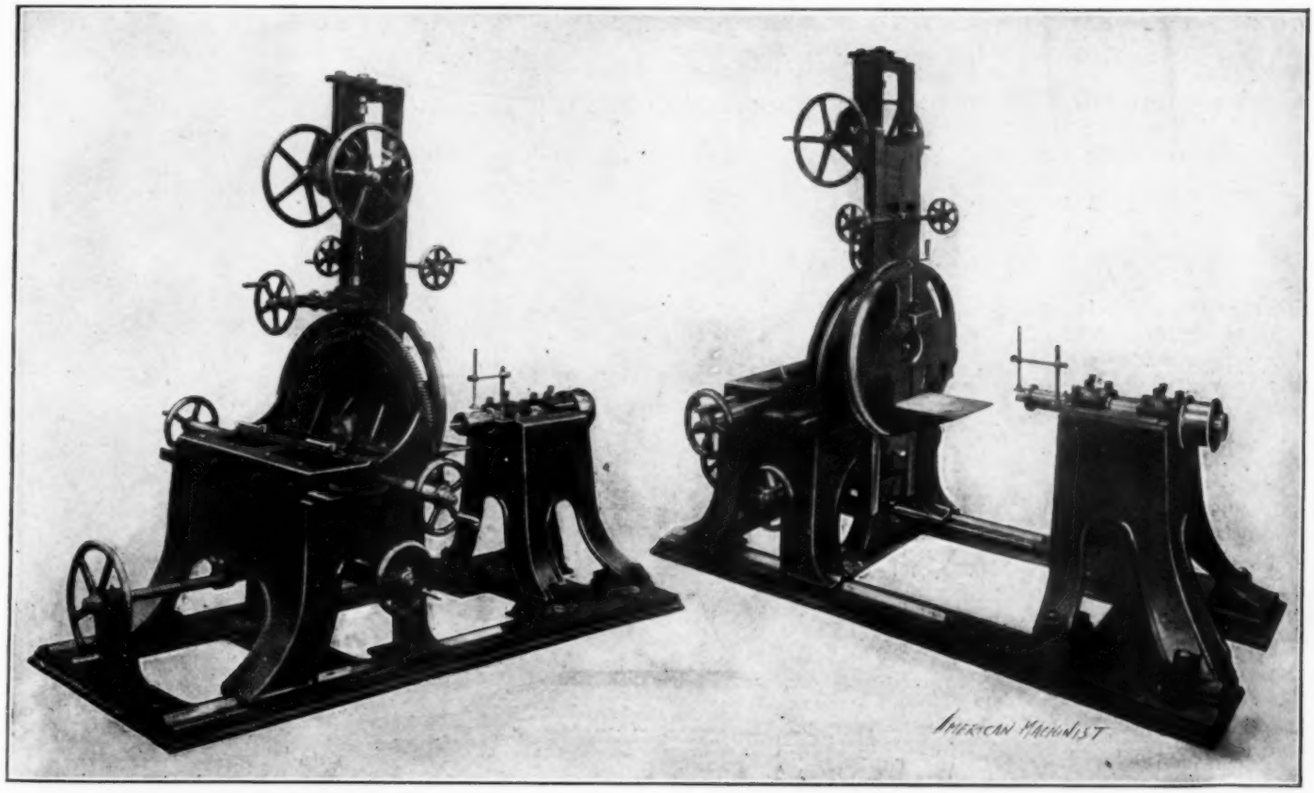


FIG. 3. WOODWORKER WITH RECTANGULAR WORK HOLDER

OPERATING STAND FOR WORK

The work carrier is arranged on a



FIGS. 1 AND 2. BACK AND FRONT VIEW OF R. S. ALLEN & CO.'S WOODWORKER WITH CIRCULAR WORK HOLDER

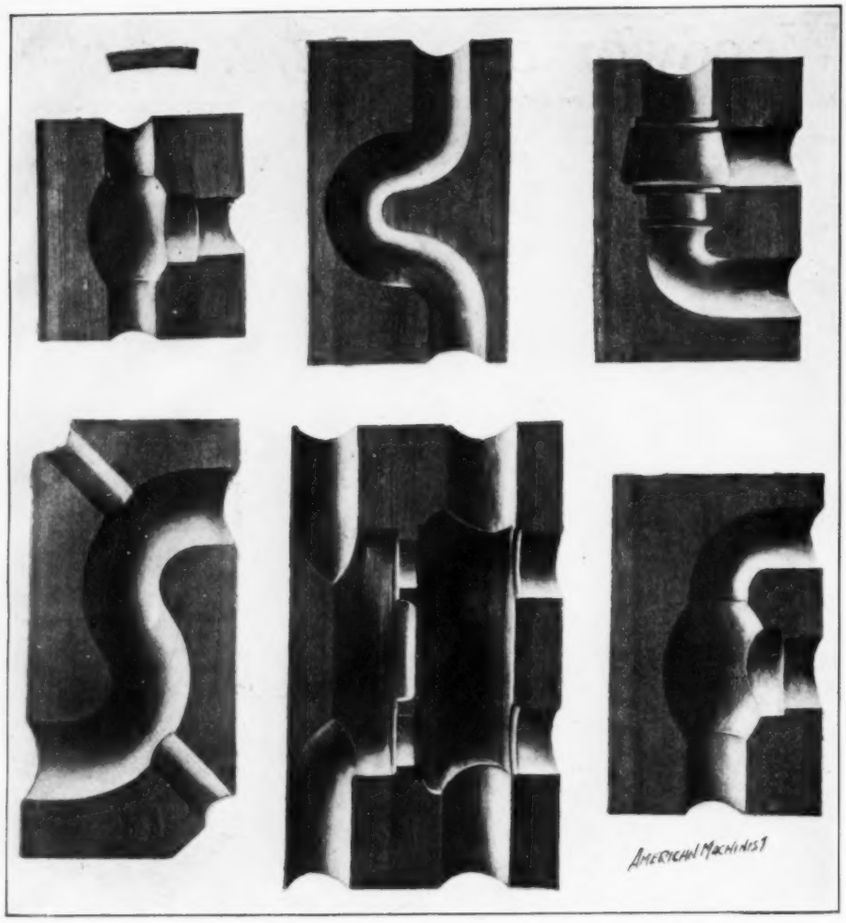


FIG. 4. A FEW SAMPLES OF CORE-BOX WORK

stand opposite the cutter spindle and will give the job practically any motion in a vertical plane. The stand itself is supported by four feet that move on V guides on the bedplate, adjustment along the bed being obtained by a square-thread screw and handwheel at the back end of the machine. On the stand, compound slides are arranged so that by means of screws driven from either side by handwheels, and by bevel gear where necessary, movement can be obtained in either direction both parallel to the cutter axis and square with it. The compound slide carries a table with a semi-circular bracket containing a toothed quadrant, facing the spindle, and a concentric slot in which a locking bolt fits. The movement of this table is, of course, at right angles to the spindle axis, the remaining handwheels immediately over the stand giving the necessary control.

Hung on the face of the quadrant from a central pin, is a long rectangular frame with guides to carry a slide. By means of a bevel gear and worm, and the quadrant at the back, this frame can be set to any angle and locked by the bolt in the concentric slot. The slide on the face of the frame is raised or lowered by a long screw, controlled by the large handwheels at the top and bevel gear. This is best shown in Fig. 1. Full control of this slide, and, in fact, of the whole machine, can be obtained from either side.

Two kinds of work-carrier are provided, one circular as shown in Figs. 1 and 2, and the other horizontal as shown in Fig. 3.

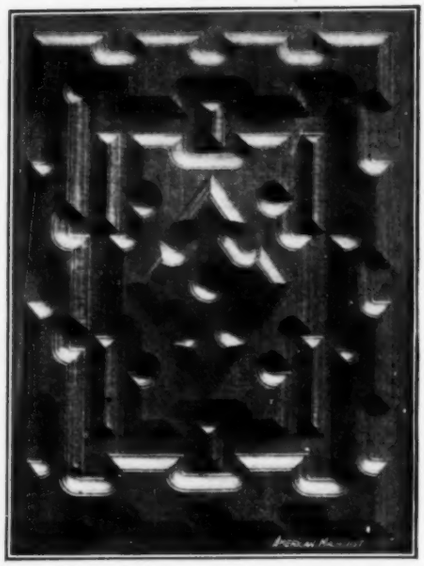


FIG. 6. PANEL CUT FROM THE SOLID

CIRCULAR WORK CARRIER

The circular work-carrier is supported on the face of the slide by the pivot bolt, as shown in Figs. 1 and 2. On its rim, teeth are cut so that circular motion in either direction can be obtained by means of a worm and wormwheel. An automatic plunger also engages in the rim so that various angles can be accurately and quickly cut. Where the circular motion is particularly useful for pattern-makers is shown in Fig. 4 by the samples of core boxes that were cut out of the solid block on this machine, exactly as they are shown. In operating the machine the work is under direct ob-

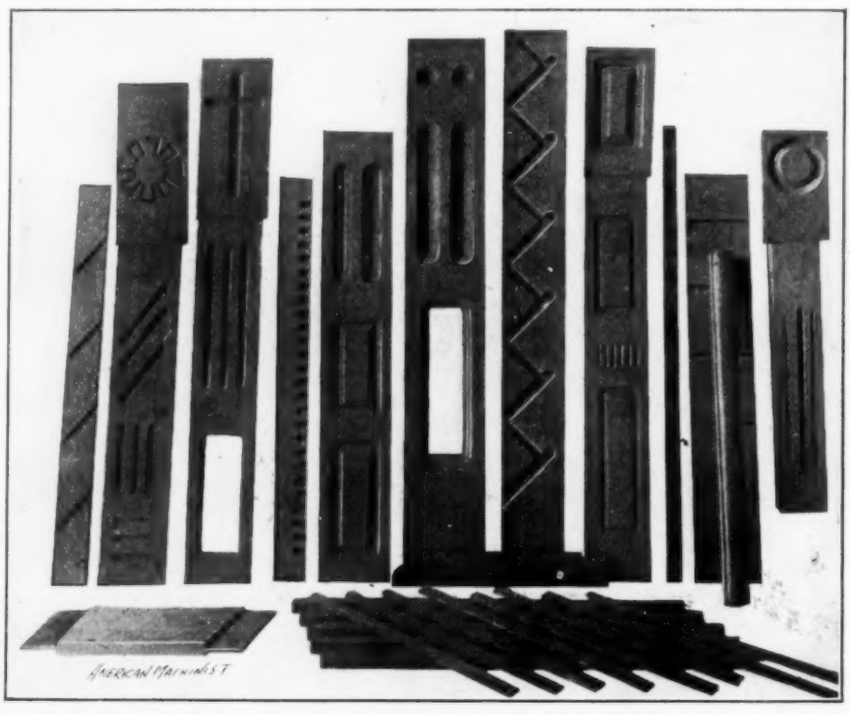


FIG. 5. SAMPLES OF WORK FO HOUSE FINISHING

servation and complete control. A groove 3 to 4 inches in diameter and 20 inches long has been cut in half a minute. The work that can be done with this machine by patternmakers is not limited to core boxes, as many intricate and difficult pattern shapes can also be cut economically on it. In fact, about the only limit of the machine is the ingenuity of the operator in designing cutters; preparing and locating stops for the work; combining or working singly, the different motions that can be given the work and locating the work at any desired angle or flat on work carriers.

Horizontal Work Carrier

The horizontal carrier is of special value to ships' carpenters, cabinetmakers, house-trimming manufacturers, etc., but much of the work that it does, samples of which are shown in Fig. 5, can be successfully and economically adapted to patternmaking. It bears clamps for holding the work and adjustable stops and guides for its control. Whatever angle of cut is necessary can be obtained by setting the long frame, while the work carrier, bolted to the face of the slide, remains horizontal.

Work of any length and thickness and up to 12 inches wide can be passed across the cutter at an angle without displacing the job from the horizontal position. Adjustable stops on the lower flange of the work carrier can be set to any angle to engage a groove or cut already made, and enable the machine to do the work of setting out, as for a series of parallel grooves and stair stringers. In fact, stringer boards 25 feet long in teak have been grooved. The machine is not limited to work 12 inches wide as the mahogany panel shown in Fig. 6 was cut on it with a single tool and it was 18 inches wide and 24 inches long.

Co-operative Education at Fitchburg *By F. A. Halsey*

In the course of the recent article on the General Electric Company's apprenticeship system, mention was made of the coöperative plan as applied at Fitchburg to the training of apprentices.

The system as applied in Fitchburg is a close copy of Professor Schneider's plan as carried on at Cincinnati, except that the boys are younger, the school work is of high-school grade only, and the aim is to train mechanics and not engineers. So far as the pairing of the boys and the alternation of work between school and shop are concerned, the methods are identical.

The Fitchburg plan is, moreover, the direct outgrowth of Professor Schneider's work and more especially of an address given by him in New York in April, 1908. The seed of this address fell on fruitful soil in the person of Daniel Simonds, president of the Simonds Manufacturing Company, of Fitchburg, who was present and who was impressed with the feasibility of the plan as adapted to conditions in Fitchburg. Upon his return home he took up the subject with other manufacturers, and the result was a plan which was presented to the mayor and school committee and put into operation at the beginning of the school year 1908-09.

Those behind the movement were farsighted enough to recognize that if the school work was to be given the bearing and application to the shop work contemplated, a special teacher would be required and the result was the engagement of William B. Hunter, who combines in himself the qualifications due to the fact that he is a practical machinist, having served his time at the trade, and also a graduate of the Massachusetts Institute of Technology. The school work is entirely in the hands of Mr. Hunter and it is largely due to his understanding of the requirements that the work has been so successful.

The Number Enrolled

The length of the course covers four years, the first of which, however, is spent entirely in the high school—the half-time feature and the work in the shop beginning with the second year. Candidates for the course are restricted to those who have finished the grammar-school work and, so far as actual starting upon the shop work is concerned, the resrtiction cuts out all who have not completed a full year in the high school. These restrictions make it impossible for any large showing of numbers to be made, but, measured by the percentage test, the results are most gratifying, the number of boys selecting the course last fall being a total of 35 out of a possible 100. Not all of these, however, were admitted to the course, the requirements of which further provide for the satisfactory completion of a two months' trial term in the shops and for this and other reasons the number admitted was reduced to 20. At the beginning of the school year 1908-09 the number admitted was 22 out of 40 applicants, the total now enrolled for the course being 42.

Reclaiming Boys to School Work

Educators who are lamenting the failuse of the public schools to hold pupils beyond the compulsory school age will be interested to know that of this number eight or ten had definitely abandoned further work at school, to which they were reclaimed by the attractiveness of the course. An unknown additional number were ready to leave school and would have done so but for the new opportunities offered.

Further ambition is beginning to show itself, one of the boys contemplating entering the coöperative engineering course at Cincinnati, while several others contemplate entering the Worcester Polytechnic Institute. These ambitions are entirely apart from the school plan, which aims directly at the training of mechanics. Mr. Hunter distinctly disclaims any idea that the aim is to make the coöperative work a preparatory school for institutes of technology.

Safeguarding the Shop Work

The number of boys at present at work in any shop is not sufficient to justify the employment of a shop teacher, but in the fact that Fitchburg manufacturing enterprises are not of that great magnitude which leads to an apprentice being lost sight of and in a provision whereby Mr. Hunter regularly visits the shops and supervises the work given to the boys there lies an important safeguard. Moreover, the agreement papers, signed by both manufacturer and apprentice, specify that the boy shall be taught the fundamental operations of various shop tools and processes under competent foremen—a provision that is usually lacking in apprenticeship papers.

The apprentices are made to understand that they are at full liberty to complain to Mr. Hunter in case they are not satisfied with the work given them, a substantial check being thus placed upon the tendency to make an apprentice into a stock room clerk or otherwise give him work not in accordance with the spirit of the enterprise. The plan is the work of the manufacturers of Fitchburg, the idea behind it being the training of competent workmen and, recognizing that it is impossible for them to supervise personally the actual work of each apprentice, they have placed in Mr. Hunter's hands a large measure of control of this work in order to protect the enterprise from the prevailing tendency of apprenticeship as commonly carried on. The actual instruction in shop work is by the various shop foremen, actual commercial work being done.

The rates of pay for the three years of coöperative shop work and for the actual time spent in the shops are as follows:

For the first year 10 cents per hour,
For the second year 11 cents per hour,
For the third year 12½ cents per hour.

While the half-time plan is carried out during the school year, full-time work is provided for the apprentices during school vacations, except that a two-

weeks' vacation is given them each summer. A formal indentured apprenticeship agreement is executed, subject to the apprentice doing satisfactory work in both school and shop.

Without attempting to give a full schedule of the school work, it is sufficient to say that it is made up in the main of English, commercial geography, shop mathematics, mechanics, physics, chemistry, mechanism, American history, free-hand and mechanical drawing, and first aid to the injured.

The Plan Has Furnished Surprising Educational Results

The manufacturers consider the plan to be already a proved success, while the school authorities are enthusiastic in their indorsement of it. The superintendent of schools, Mr. Edgerly, while admitting himself somewhat lukewarm at the beginning, now speaks of the plan as a "decided success." He also finds that, as regards the amount of school work done, the result is substantially the same as that obtained in Cincinnati, his words being: "I have seldom noticed more earnestness displayed by pupils than the members of this class have evinced during the year, and I have watched their class-room work carefully. Figures cannot, as a matter of course, be presented, but no doubt exists in my mind that these pupils are making progress in their studies very little, if any, less than would be made should they attend school the entire time the school is in session."

This experience is exactly in line with that obtained by Professor Schneider and there is indeed nothing improbable about it. Most boys do not love their books, and while some do, the old saying that "all work and no play makes Jack a dull boy" is just as true of school work as of any other. Too much book work becomes drudgery, especially to the young mind which craves variety. In view of the alternation of the two kinds of work and of the stimulation which is inherent in the close relation of the two, there is nothing unreasonable in the opinion given.

Advantages of the Co-operative Plan

The American Machinist has nothing but sympathy and good wishes for any and all plans for the better training of more mechanics. At the same time, it does seem to us that the coöperative plan possesses larger possibilities of usefulness than any other that has been proposed. It places upon the taxpayer almost no burden of taxation, and it places upon the public-school authorities no great problems which are entirely novel and untried and with which there is at least grave doubt of their ability to cope. It gives boys a chance to earn something, which with many is necessary, and for others it provides an outlet for the praiseworthy desire to get to work and be doing something, while at the same time it accomplishes what the educators so much desire, that is, the keeping of the boys in school for a longer period than now commonly prevails. It trains mechanics where they have always been trained, and it requires the employer, as many believe he should be required, to train his own workmen. Finally, it puts apprentices in the shops *now*, instead of promising them skilled workmen three or four years hence.

The shops are anxious to get apprentices, the schools are anxious to hold their pupils and the boys are willing to continue at school, if, in connection with school duties, they can begin useful work. It would be a captious critic indeed who could quarrel with a plan which so perfectly meets the wants of all concerned.

Future Outlook for Wide Application

Whatever may be the outcome of other methods of training mechanics, the future before the coöperative plan is undoubtedly a large one. Its application is as wide as the field of industry and as the nation itself. It involves less that is experimental, less difficulty of organization and less expenditure of money, with all the difficulties involved in raising it, than any other, while it offers more immediate and more widespread results.

The necessary plant for both phases of the work is already provided. No long program of local agitation is necessary before making a beginning. Local school boards have now sufficient authority and they only need be moved to action. Meanwhile no one is more alive than the school authorities to the fact that the public schools do not meet the needs of the country. In a vague way they feel the need of some sort of vocational work and with a little effort they may be led to see the great possibilities which this plan opens up for the public schools.

In a larger way the plan removes the reproach that the public schools are now conducted for the few who look forward to the college and the university—that they offer no schemes of education except those which have a scholastic end. The whole plan is thoroughly democratic and in accord with the best traditions of the Republic. It is a tangible, practical outcome of a flood of discussion and it deserves and will, we believe, receive wide adoption.

Contrary to impressions in some quarters the plan is as yet applied to the metal trades only because the metal manufacturers first saw its value and moved energetically for its adoption. It is applicable to all vocations for boys and girls and is suited to all localities and industries.

Different Methods of Keying Sliding Worms

By R. Nielsen

Probably one of the most difficult places to set a key is in a worm that is to slide on a splined shaft, as sometimes such a worm is subject to great strain and therefore the key must be put in securely.

The best but most expensive is shown in Fig. 1. With a little skill a key can be set very well as shown in Fig. 2. A hole is drilled and counterbored at *a*, Fig. 2, to receive the end of the key which is bent over and filed to fit it but

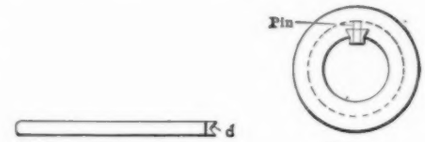


Fig. 1

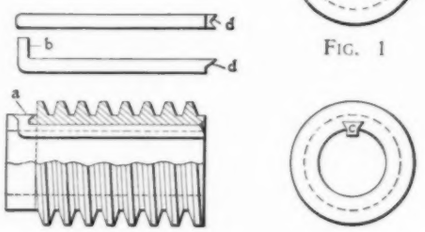


Fig. 2

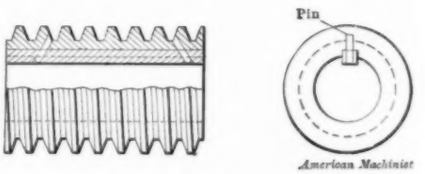


Fig. 3
Keying Sliding Worms

left a little longer as shown at *b* to allow for riveting. The other end of the worm is filed as at *c* and the key filed as shown at *d*. The corners can then be riveted over into the corners in the worm. The method shown in Fig. 2 can only be used if the worm has an end where there are no threads. Fig. 3 is the simplest way and can be used on most every worm; the only thing to take care of is that the drill does not push the key down while drilling.

In the annual report of the engineer-in-chief of the United States navy, reference is made to the rapid progress in the development of large gas-engine machinery operated in connection with gas producers. The report states that it is possible to design a marine plant composed of bituminous-coal gas producers furnishing power to gas engines. There are several such plants already in existence; and although they are small, they prove the feasibility of extending this system of developing power to larger installations.

LETTERS · FROM · PRACTICAL · MEN

Concerning the Details of making things in machine shops, from the first sketch to the sale

Automatic Indexing Device for Gear Cutter

Having had considerable experience with automatic gear-cutting machines, I find in some cases there is room for improvement with the indexing mechanism. With this in mind I have designed the automatic indexing attachment shown in the accompanying drawings, and which, so far as I know, is original with me. It takes up comparatively little space and after six months' use has proved successful; it is positive in its action and accurate. The driving pulley running at a speed of 90 revolutions per minute indexes without shock or rebound of any kind, and indexing for a small number of teeth, say 15, is done very quickly. I have one machine alongside of this one with semi-friction indexing device on which I have to let the cutter run back ½ inch beyond the face of the work when set for 15 teeth, on account of the slowness of the indexing, while this attachment will index within 1/16 inch of the face of the gears on a small number of teeth and even closer for a larger number of teeth, and it cannot index for one-half tooth.

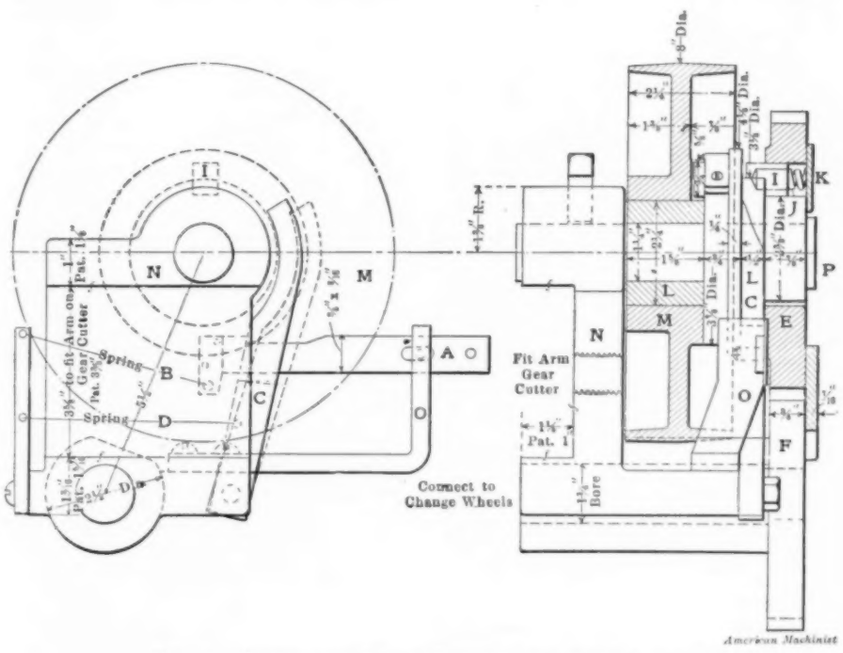


FIG. 1. AUTOMATIC INDEX FIXTURE FOR GEAR CUTTER

The following is a description of the attachment: *A*, Fig. 1, is a lever which, when coming in contact with the pin on the carriage of the gear cutter, causes the mechanism to operate. *B* is the spring which pulls lever *A* back and upward, causing it to engage in arm *C*, which has a slot milled in its side for the purpose. Now, when lever *A* is pulled for the indexing of one tooth, it will not index another tooth without being returned to its original position, as the drawing indicates; when pulled it allows pin *I* to engage in the teeth cut in the hub of driving pulley *M*, and as pin *I* revolves it comes in contact with the end of lever *A*, which causes spring *D* to pull arm *C* back to its original position, and when pin *I* comes around again arm *C* draws pin *I* out of the teeth in the hub of driving pulley *M*. *E* and *F* are a pair of intermittent gears, *E* being the driver, *F* the driven. Fig. 2 is a detail of these gears.

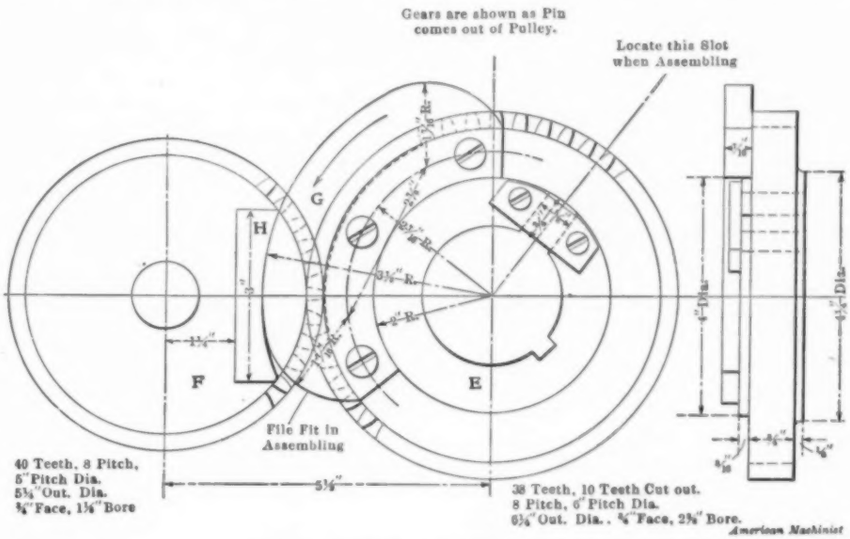

Gears are shown as Pin comes out of Pulley.
Locate this Slot when Assembling
File Fit in Assembling
40 Teeth, 8 Pitch, 5" Pitch Dia. 5⅓" Out. Dia. ¾" Face, 1⅛" Bore
38 Teeth, 10 Teeth Cut out. 8 Pitch, 6" Pitch Dia. 6⅓" Out. Dia., ¾" Face, 2⅜" Bore.
American Machinist

FIG. 2. GEARS FOR INDEX DEVICE

Gear *E* is 6-inch pitch diameter, the proper size for 48 teeth, 8-pitch; 10 of these teeth are cut out, leaving 38 teeth in the gear and in place of the 10 teeth, which are omitted, locking plate *G* is doweled and screwed fast to the side of gear *E*. When gear *F*, which is 5-inch pitch diameter, 40 teeth, 8 pitch, makes one revolution, plate *G* engages with another locking plate *H*, which is solid on steel wheel *F*; this makes it positive in action as can be plainly seen by the drawing. After indexing, wheel *E*, which is set so pin *I* pulls out in the center of the portion where the 10 teeth were cut out of *E*, gives 1½ inches movement each side of the center on the pitch line of the gears without turning wheel *F*. So if pin *I* does not engage or disengage at the exact place it does not in any way interfere with indexing the wheels accurately.

Spring *J* operates pin *I*. Plate *K* has a 3/16-inch pin which passes inside of spring *J* and holds it in position. Pulley *M* runs loose on bush *L*. Stud *P* carries parts *E L M* in base *N*, which slides on the arm of the gear cutter and is connected to the index-change wheels.

J. R. DUNHAM.

New Brunswick, N. J.

An Experience in Hardening Ring Gears

The experience herein described occurred in connection with the manufacture of a number of bevel-ring gears for use in automobiles. These gears were

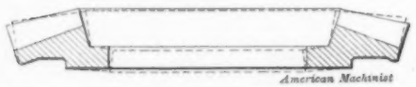


FIG. 1. EFFECT OF DOUBLE-HEAT PROCESS

FIG. 2. EFFECT OF SINGLE-HEAT PROCESS

about 9 inches in diameter with 4½-inch hole. They were cut from a forged blank that was machined all over, except on the back. The steel was of special composition that contained about 0.20 per cent. of carbon.

Before hardening, these gears were carbonized in a gas furnace by packing in new and old bone in the proportion of 7 to 10, and when submitting them to an even temperature of 1560 degrees Fahrenheit for about seven hours. In this time they would absorb enough carbon to produce a case about 1/64 inch deep. After having cooled they were again heated to about 1500 degrees Fahrenheit and quenched in oil, and then were drawing in oil heated to about 430 degrees Fahrenheit.

After a number of gears had been made the specifications were changed on both the steel and the treatment.

DIFFERENT STEEL AND TREATMENT

The new treatment was to heat after carbonizing to about 1560 degrees Fahrenheit and quenched in oil, then reheated to 1430 degrees Fahrenheit and again quenched in oil and then draw in oil at 430 degrees Fahrenheit.

The object of this treatment was to refine the steel as well as produce a hardened case. The fracture showed a remarkable refinement of the grain and a good substantial case that was hard but not brittle. But this method was not long in use before it brought forth complaints both from the customer and also the grinding department.

The former claimed that the limits were being exceeded; the latter that too much stock was being left on for grinding. Here they insisted that from 0.020 to 0.030 inch was left on the back and in the hole, while the allowance made in turning and boring the blank was but 0.005.

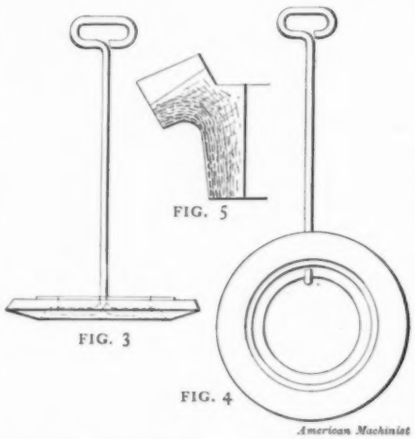
The difference was caused in heat treating, and the grinding trouble was adjusted by making smaller allowance. In fact, the hole was bored 0.005 large and the back left to size, but still complaints of too much stock were made.

The hardened gears, when calipered, were found to be from 0.010 to 0.040 small in diameter. The fault was charged up to the change in steel and method of treatment.

EFFECTIVE IMPROVEMENTS

A few experiments were then decided upon and after considering all points, and on the advice of an expert, the carbonized gears were heated to 1430 degrees, quenched in brine and then drawn to 430 degrees Fahrenheit in oil. This method proved effective in so far as the diameter of the gears was concerned, it varying but a couple of thousandths or so. The fracture was good and the case was deep and hard.

A batch of gears were put through under this process and when they reached the grinder, it was found that there was not enough stock by 0.003 or 0.004. In order to find out what was the cause and whether a remedy could be



METHOD OF DIPPING AND GRAIN IN FORGING

found I took some of the hardened gears that were treated under each method before they were ground and found the conditions shown in Figs. 1 and 2, Fig. 1 being that of the double heat-treated gears and Fig. 2 of the single heat-treated gears. The dotted lines show the size and shape of the gears after the heat treatment.

It was found that while the gears were remarkably flat and would run very true, those treated by the double heating were bulged on the backing, small in diameter, and the hole was tapered, as shown by dotted lines in Fig. 1. This accounted for the large amount of stock in the hole and on the back, and further investigation showed that some of the gears would not grind to a surface in the back end of the bore and on the outer edge of the backing.

The effect of the single treatment, shown in Fig. 2, was just the opposite of that in the double, and accounts for the lack of stock in the hole and on the back.

The method of dipping the gears in the double-heating process was to dip face down, as shown in Fig. 3, and in the single-heating process the gears were dipped in the brine edge first, as shown in Fig. 4.

Another method used when working the same gear is to carbonize and then heat to about 1300 degrees Fahrenheit in a lead bath and quench in oil, after which draw to 430 degrees Fahrenheit in an oil bath.

The gears were covered all over with a coating of fireclay about ⅛ inch thick except between the teeth before packing in the bone. This left the gear soft except on the surfaces of the teeth.

SATISFACTORY RESULTS

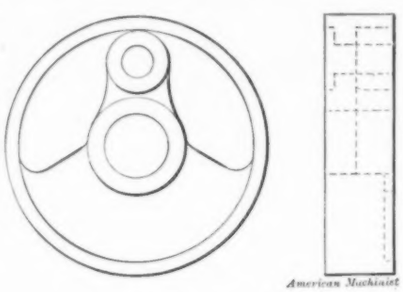
Under this process they come out reasonably straight and true, and but one in a large number ever have to be straightened which is possible here because the gears are soft. Leaving the bore and back soft also enables the grinding to be done in about one-fifth the time.

Much of the trouble from distortion in heat treating is caused by forging at too low a heat; in which case the metal does not have the chance to flow properly and is merely forced into shape by the die. This sets up internal strains that will release themselves when the outer skin is removed and the part reheated. Fig. 5 shows the grain that was found in breaking a number of gears. The fracture was much like that of wrought iron and showed coarse fibers that closely followed the shape of the forging. This could only be produced by forging at a low heat. When this gear was hardened the outer edge showed a tendency to straighten out much like that in Fig. 1.

Ontario, Can. JOHN GARED.

Boring Crank Pin Holes in Crank Disks

I have experienced great difficulty in getting crank-pin holes dead true and parallel to the shaft, especially in the



THE DISKS TO BE BORED

larger sizes. The system has been to bore both the shaft and crank-pin holes in the disk, in a lathe, and then keyway

them. They are bored about 0.005 inch small. Heaters are then placed on the disk and when it has expanded enough the shaft is dropped in. The disks are irregular in thickness, having a balance weight on one side as shown. When cool we find they are distorted to such an extent that when the connecting rod (some 7 to 8 feet long) is coupled up with the crosshead end free, and the crank pin is set on its four opposite centers, the free end will show a variation of 1/16 inch from true position. Will some kind reader give a kink how this can be avoided and at a minimum cost?

H. MAPLETHORPE.

Darlston, Eng.

[As no sizes of shafts are given this looks more like a guessing contest than anything else. Our guess is that: 0.005 inch is the shrinkage allowance for about 1½ inches diameter of shaft which certainly could not be one of the "larger sizes" with a connecting rod "7 to 8 feet long." Say the shaft is 6 inches diameter 0.005 inch is a very small *force fit* allowance for this size. If the heating distorts the disks don't heat them, they will push on easily if only 0.005 inch smaller than the shaft. Boring in the lathe, if carefully done on a true lathe, ought to produce as good work as any other method. —ED.]

Some Fusion Welding Jobs

In the welding plant I am conducting for the purpose of repairing machinery

FIG. 1. BROKEN PRESS FRAME BEFORE WELDING

and automobiles, we are often called upon to weld broken automobile frames. Some are broken in front of the radiator, while others are broken about midway of the chassis.

When broken in front we simply remove the radiator, jack up the car sufficiently to remove the weight from the front springs and disconnect the front end of the springs. We then place the broken ends in line and hold them until they are fused together in several spots, with the torch. We then straighten the frame again and proceed to weld around the fracture the same as when welding two pieces of pipe end to end. This amount of welding takes about two minutes. We then take a plate of a thickness and width equal to the bottom flange of the frame and about 6 inches long, and weld it solid to the bottom flange, across the fracture. This stiffens the frame and prevents any future fracture

FIG. 2. PRESS FRAME AFTER COMPLETION OF WELDING

in the weld. This operation requires about two hours to dismantle, weld and replace the parts.

When the frames are broken in the middle we have to remove the tonneau and any oil pipes or small parts that are in that section of the frame. We then use two jacks and raise the broken ends until they are true, or in the original position, and then proceed to weld as above.

In repairing heavy castings we find they do not weld readily, without defects in the welds. For this reason we use Tobin bronze as the fusing stick, and find that it takes less heat and makes a more secure weld. For the flux we use ordinary "20-mule team borax." The Tobin bronze has a tensile strength greater than cast or malleable iron.

The success of this method of welding is shown by Figs. 1, 2 and 3. In Fig. 1

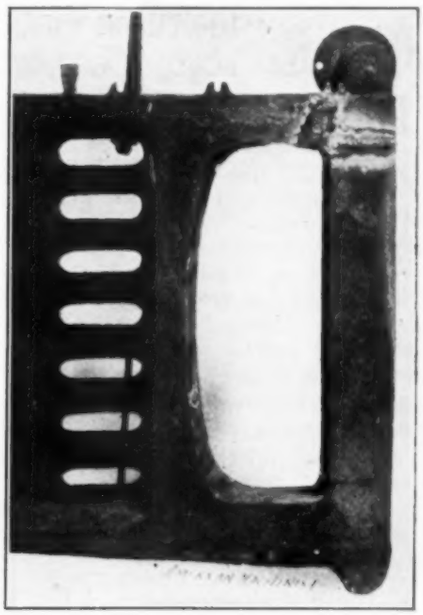


FIG. 3. WATER-HEATER CASTING SAVED BY WELDING

the broken press frame shows the extent of the fracture. This frame was broken by strains in service and not through an accident. Since welding, as shown in Fig. 2, it has been in service one month and is doing the same work as before.

In Fig. 3 is shown a water-heater casting that was broken by the engineer turning cold water in it while hot. This was welded as shown by this process.

Both the castings shown weigh about 800 pounds and were welded with F. C. Sanford Manufacturing Company's welding outfit, which we find capable of doing almost anything in the repair line.

Baltimore, Md. J. B. ADAMS.

Shape of Figures to Avoid Chances of Mistakes

Just a word in behalf of the machinist who is compelled to work in the dark and dingy shops from blueprints where the figure "9" is used thus by the Mr. Engineer. I have seen three mistakes occur in one year, the machinist taking the figure 9 for a figure 6 in a hurry, laying out a breakdown job.

I wish to bring this to the attention of the engineers and ask them to abandon the use of the figure 9 as commonly shown, using the nine with the straight leg instead, thus avoiding a common cause of error.

Likewise the use of the curve top in the figure 3 is apt to cause confusion with the figure 8 in many instances.

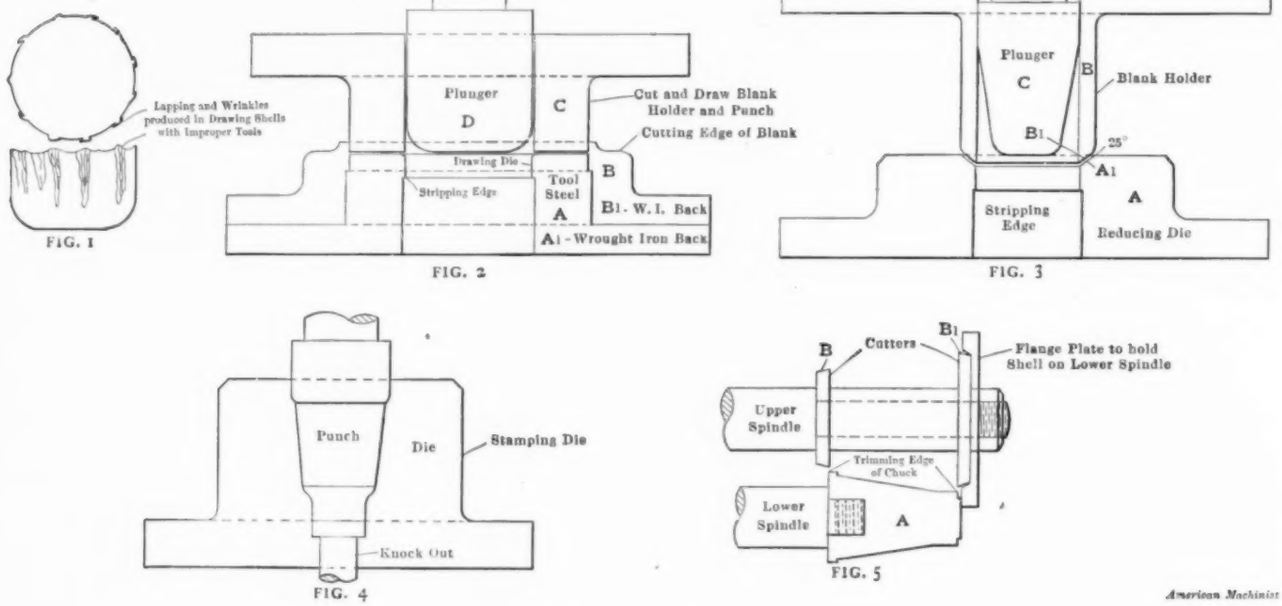
Cleveland, O. WILLIAM SHEESLEY.

? DISCUSSION of the PREVIOUS QUESTION ?

Letters from our Readers showing how many Men of many Minds look upon Various Subjects Opened up in previous Numbers

Dies for Forming Tubes

With reference to the article by P. P. Monfils at page 1099, Volume 32, Part 2, in regard to tools necessary to make the brass shell as submitted by A. C. Card on page 839, I wish to say that the method as described in that article is misleading and too much is left to the imagination of Mr. Card in that the operations are not practical and entirely



DIES FOR FORMING TUBES

too long drawn out to suit the requirements of the practice today on such work.

In the first place, the first shell or cup that is drawn from the flat blank has to be as nearly perfect as it is possible to make it, as the imperfections of the first shell are always duplicated more or less in each successive operation and to use stock the thickness of which is specified by Mr. Card, makes it an impossibility to draw this shell or cup with any hight of wall in a die as shown by Mr. Monfils in his Fig. 2 as the flat blank in being turned into a cup this fashion would wrinkle and lap badly as indicated in Fig. 1 herewith, and the result would be of no use for any operations to follow.

Secondly, the operations would be entirely too numerous in the die as described in connection with Fig. 3, of this article, in that the reduction on the wall would be so small on account of still further wrinkling or lapping in bringing the shell down to the base size, which in this instance is 2 inches.

Thirdly, to punch the bottom as shown by him in his Fig. 6, has become more or less obsolete among manufacturers that are up to date, on account of its uncertainty, and a cutting-off operation is substituted, which, in a great many cases is combined with the trimming off of the superfluous stock at the big end, and the whole shell made in 3 press operations, one anneal, and a combination trim and cutoff as described below.

Fig. 2 herewith represents the cut-and-draw double-action die which has been described at various times in the AMERICAN MACHINIST, but for the benefit of both Mr. Card and Mr. Monfils, I show it again. *A* is the drawing ring, which is made of tool steel hardened and ground with a wrought-iron back *A*1. This fits into the cutting edge *B*, which is also hardened and ground with a wrought-iron back *B*1, and the two are then fastened together with several screws, not shown. *C* is the cut-and-draw blank holder which performs the double task of cutting the blank and holding it with sufficient pressure against the face of the die *A*, so that the stock can be drawn away slowly and evenly into a cup or shell by plunger *D*, the lower corners of which are rounded to assist in drawing the shell, and to ease the second operation in reducing the shell.

Fig. 3 represents a double-action reducing die *A* which is also hardened and ground, and at the drawing point, marked *A*1 the face is beveled off to 25 degrees which in practice has done wonders for shells of deep draw. The blank holder is marked *B*, and the outside diameter is turned off so that the first-operation shell will slip over it, which insures the shell being reduced uniformly and also holds it centrally in reducing. This blank holder has a nose *B*1 also beveled off at an angle of 25 degrees so as to correspond with the drawing face of the die *A*1 and in turn holds the shell and allows the plunger *C* to draw the shell down through the die. Note the peculiar shape of this plunger *C* which is so made that it coincides as nearly as possible in both shape and amount of stock required, so that in the third operation, which is a single-action stamping one, the shell is pressed into the shape as outlined by Mr. Card.

Fig. 4 represents the single-action stamping die which stamps the shells from the preceding die into shape. Before attempting this operation, however, it is best to anneal the shells to prevent any splitting or breaking if they have to be plated or oxidized. It will be noted that the shell at its smallest end is drawn

1/16 inch longer than is required. This is done purposely so that in cutting off the bottom, the cutter doing this work is on the clear wall, and will cut off with scarcely any bur.

Fig. 5 represents the combined operation of trimming and cutting off the shell, and is usually done in a parallel trimming lathe with a chuck *A* so arranged at each end that the cutters *B* and B_1 engage the ends and the shell is trimmed and cut off to the exact length. It is customary to make cutter *B* about 1/16 inch larger in diameter in proportion to its end of the work so that the shell is trimmed first, and then cut off.

I want to say in finishing that the blank has not been figured, but in the first operation for size of shell it ought to give a 2⅝ inch diameter.

Buffalo, N. Y. A. C. RANTSCH.

Boring a Flywheel—Using a Wooden Boring Bar

Referring to Mr. Dane's article at page 956, Volume 32, Part 2, on boring a flywheel with a wooden boring bar having an inserted cutter, I would like to ask him what method was used to keep the cutter *C* from jumping into the keyways, thereby allowing the boring bar *A* to fall through the bore. There is no device shown to overcome this difficulty.

Bridgeport, Conn. GEO. E. DAWSON.

Graphite Bearings and Unnecessary Work

John R. Godfrey, in his article on page 1019, Vol. 32, Part 2, gives me an incentive to suggest a scheme even more "fishy" than his file story. I have a great scheme for making cast-iron bearings. Of course, we all know that gray cast iron is simply iron with a little graphite in it, that is, graphitic carbon as well as combined carbon. Now my scheme is to ream the bearings out a little small, plug up the ends and fill with acid, any kind that likes iron to eat. After a reasonable time to be settled on by experience, the bearing should be washed out and an arbor or mandrel of the size of the intended bearing forced through. Now see what we have. The acid eats out the iron from around the crystals of graphite, the graphite is smoothed down by the mandrel. We have, therefore, a cast-iron box lined with graphite cast in place and securely held.

Mr. Godfrey is not the only man that has noticed unnecessary machine work being done. Our old friend Chordal used to talk about the impossibility of getting careful, accurate work done on a "black" machine, that is, one without unnecessary polish. There is that same element in a machinist that pervades the rest of the world and which makes us all look at the price tag to get at the quality of the machine. Some ten years ago I bought a lawn mower. The little Entropies were coming along just then so naturally I spent a couple of dollars' worth of time hunting for the cheapest machine. I looked the machines all over and I could not see where there was any difference in their usefulness. The holes were all reamed for bearings. There was ample room for oil and anything that stuck to the oil between the shafts and the bearings on all of them. The thing has run thus ten seasons, mowing stones, wires, playthings, plants, shrubs and everything else that any other lawn mower mows. That lawn mower would not have been improved by being made to half-thousandths limits. It was good enough to use but it wasn't good enough to sell. They told me in the store that they did not sell those machines, they only used them for bait to draw in customers who would buy better, or more expensive machines.

There are a few of us, say, nine-tenths of us for a guess, that hate to buy what we really want after anyone has told us that nobody buys the cheap kind. It is the same way in the shop. After we are rigged up to do a job in good shape we hate to have some one come along and tell us that it ought to have been cast that way in the first place. Possibly the fact that in this country the foundries and machine shops being separate establishments has something to do with our inclination to think that everything that comes from the foundry needs planing or milling before it is used. If the shops ran their own foundries and there were no such thing as human nature we would get perfect castings. Fact is, though, that the shops that do run their own foundries get the worst castings. It is just a case of "good enough for us and we are in a rush."

That is what we usually think of as the difference between the amateur and the journeyman. The first makes things well enough for his own use, the other makes them well enough to sell and stay sold, but I notice that the average shop does its own work in a very amateurish manner. Take a special machine. The chances are that if made in the shop, the castings are not half cleaned. The tool marks show all over it and it never gets painted.

If the same machine had been made outside you never would have accepted it until $10 had been spent on it fixing up these little things. That $10 does you no good, so far as productivity is concerned; it does do good in the respect that your men have for it. That lasts up to the time when the thing needs painting and polishing again. Then the respect is gone. The ideal shop condition is that in which everything is kept up in apple-pie order and polished and painted like new. If you do not do that you might just as well not paint and polish your new machinery. Experience seems to indicate that it takes a considerable amount of this unnecessary work to keep a shop out of bankruptcy.

Worcester, Mass. ENTROPY.

Thread Gages for Screw Machine Work—Limit Gages

As manufacturers of screw-cutting tools, thread gages, etc., the article by F. L. Gager, at page 745, was of great interest to us.

While in some classes of work as mentioned in Mr. Gager's article, the results obtained may justify the making of solid gages, there are very few threading operations which cannot be performed quicker, with sufficient accuracy, and with a sufficient degree of uniformity by the use of limit gages in place of the old style gage with no limit.

The American Society of Mechanical Engineers has given us the first application of the principles of limits applied to thread work, in the adoption of the "Report of the Committee on Standard Proportions for Machine Screws," Volume 29, *Transactions*, A. S. M. E.

While this is a step in the right direction, the limits allowed on this class of work could not be used on any other, and as Mr. Gager has said, "The fact is evident that there should be some limit allowed and that this limit should be represented by the gages;" it behooves every manufacturer engaged in the production of machine parts to give this subject especial study and to have the results of such study embodied in the gages made for him.

At page 524, Vol. 32, Part 1, a new style of plug limit gage as lately brought out by Wells Brothers Company, of Greenfield, Mass., was illustrated. In this type of gage two plugs are made, one having the largest limit allowed and the other the smallest limit, the former being fitted with a red fiber handle and the latter with a black fiber handle. In the case of the templet limit gage adopted, the holder containing the largest size has a ring of black fiber attached to the metal center ring and the smallest size is fitted with a ring of red fiber. These templet gages are adjusted to small plugs which are made to the maximum and minimum limits adopted for the work in hand. The templet limit gages, as made in the larger sizes, have fiber handles instead of fiber rings, this form being more convenient for the large sizes.

EDWARD BLAKE, JR.,
Wells Brothers Company.
Greenfield, Mass.

An Easy Method of Lettering —The Rubber Stamp

I have noticed several methods of lettering titles of drawings described in these columns, and I have been considerably interested in them.

The plan set forth by Mr. Davis at page 912, Volume 32, Part 2, would certainly make nice prints, if the letters were put on properly, but it seems to me that his method would require too much time for the attachment of the letters, and that if the tracings were handled much, and frequently filed in and out of the vault, they would be liable to lose some of their letters.

A method which I have used for some time and which seems to me to be the best and quickest that I have yet discovered, is to put titles on with a rubber stamp and regular drawing ink.

For applying the ink to the stamp we use a pad containing a piece of wool felt covered with linen. This is saturated with drawing ink until it gives a clear title, with solid black letters. A boy can stamp enough in an hour to last a whole month. After the first lot has been used up, should the pad be found to have hardened it can easily be softened with alcohol, and with the application of a thin coating of ink it will be ready for stamping another lot.

C. P. HARRISON.

Waynesboro, Penn.

Silent Pawls

An article appears on page 890, Volume 32, Part 2, dealing with "A Few Types of Silent Pawls." Some time ago I was confronted with the same problem and I offer two of my own solutions and one I have seen since in the speed box of a well known radial drill.

This latter device is shown in principle in Fig. 1. Gear *A* drives gear *B* which runs constantly at a slow speed in the direction of the arrow. Gear *B* runs loose on the hub of ratchet wheel *C*. This ratchet wheel is counterbored to receive the split bushing *D*, the outside of it fits snugly into the counterbore of the ratchet, while the bore of the bush is large enough to clear the shaft *E*. There is a slot milled in the flange of the bushing *D* to receive the tail end of pawl shifter *F*. Pawl *G* is connected with pawl shifter *F* by pin *H*. Both pieces, *F* and *G*, are held loosely on the stud *I*; the stud itself is screwed into gear *B*. In the sketch gear *J* is shown out of mesh with gear *K*.

As soon as it is disengaged, the speed of shaft *E* drops and when it gets below the speed of gear *B* shifter *F* brings pawl *G* into engagement with the ratchet and then drives shaft *E* at the same speed as gear *B*. When gear *J* is slipped over into mesh with gear *K* then shaft *E*, ratchet *C*, and also bushing *D* by means of its frictional contact with *C*, will run faster than gear *B*, and bushing *D* causes pawl shifter *F* and pawl *G* to swing around stud *I* until *G* comes against a stop formed by the rim of gear *B* (as shown by the dotted lines). As soon as pawl *G* is prevented from further movement it will cause bushing *D* to slip and the friction thus created between ratchet *C* and bushing *D* will keep pawl *G* out of engagement with the ratchet until the speed is changed again.

In the arrangement shown in Fig. 2

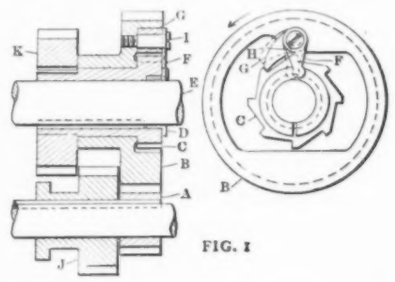


FIG. 1

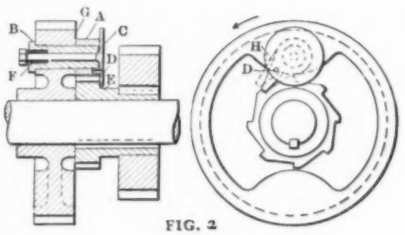


FIG. 2

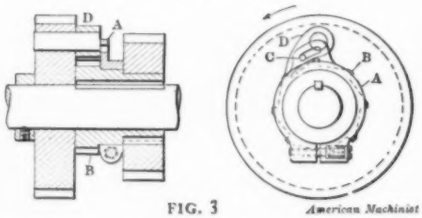


FIG. 3

THE FORMS OF SILENT PAWL MECHANISM

pawl *A* swivels around the extension of bushing *B*. Through this bushing slides the bolt *C* which has a large flange and makes connection with pawl *A* by means of pin *D*. This flange is pressed against the side of the ratchet wheel *E* by the spring *F*. The difference in speed between ratchet *E* and gear *G* will cause pawl *A* to turn until it comes either into or out of engagement with the ratchet *E* through the frictional resistance between *C* and *E*. When *G* runs ahead of *E* the pawl will engage the ratchet and when *E* turns faster than *G* the pawl will be withdrawn. Stop pin *H* prevents the pawl from swinging around too far.

Fig. 3 illustrates another device. Here a spring clamp *A* is slipped over the hub of ratchet *B*. This clamp is provided with a cam slot. In action this device works similar to the others; when the speed of *A* is higher than the one of *D*, pin *C* slides up the inclined slot in spring clamp *A* and by doing so raises the pawl out of mesh with the ratchet and the pawl is held in this position until the speed is changed. When *D* runs faster than *A*, then pin *C* is pushed down along the inclined slot and pawl *D* comes in contact with the ratchet.

Norwood, Ohio. H. R. ISLER.

Correcting an Error in a Crank Shaft

On page 999, Volume 32, Part 2, Mr. Clark gives an account of how a crank shaft was shortened. It seems that this was a *large* two-throw crank, and that it came 1 inch too long in the bearing between the throws. The forge-shop foreman heated it *sufficiently* and rushed it over to the *big* lathe and, putting it between the centers, upset the bearing by screwing up on the tailstock.

This is certainly an interesting statement of how a very difficult job was done in a very short time, and it would be hard to find a way to do it at less expense. As the plan used has possibilities of application to many other jobs, if Mr. Clark will give some further information it might serve a useful purpose.

The first point that is not altogether clear is the size of the crank that was corrected in this way. The statement is that it was a *large* crank, but "large" is often used as a relative term. In the next shop to ours a crank from 14 to 16 inches in diameter would be considered a large one. In our shop we consider one 5 inches diameter a large one, while it is possible that in some other shop a crank 2 inches or even less in diameter might be considered large. This being so, a definite statement as to the diameter of the crank at the place where the correction was made would be of benefit.

With the information at hand as to the size of the crank operated on another point of interest is the size of lathe that was used. As to the pressure that can be exerted by screwing up the tailstock the size of the lathe may not be of very great importance because a large lathe is apt to have a coarser pitch screw than a small one, so, considering the power that is applied, the squeezing force may not increase very greatly with an increase in the size of the lathe. While this is true it is also true that a large lathe will safely allow a force to be used that might injure a smaller one. Without meaning to criticize a lathe for the purposes it is designed for in ordinary practice it must be admitted that as a press the form is not all that could be desired, and it is not well to go beyond a safe point if it is to be used for such a purpose. With this point in mind the size and make of the lathe would be useful together with any possible details

that would tend to keep an ordinary man out of trouble.

The last point that is troublesome is the temperature at which this job of pressing was done. Of course the hotter it was the less pressure it would require to do the upsetting, but on the other hand, in these days of critical points and fiber fatigue, and crystalline structure and such other things it would not be desirable to go much above the recalescent point.

While it is not likely that the forge people will send out cranks in any great number that will require such treatment, yet the idea is one that might be made use of in many other ways if it can be done safely.

With my own experience of upsetting by means of sledges, battering rams, or the bulldozer as a guide I should have condemned such a method of correcting the crank if it had been suggested to me, that is, with a crank that I would consider *large*, and the job to be done on a lathe that to me would be *big*, keeping in mind that the crank must be lowered in quality by high heating.

The forge-shop foreman seems to have done the job in a manner satisfactory to those immediately concerned, which shows that he may have had experience in that line, or else that he is a man of naturally superior insight and judgment.

With more information as to what *large* represents as applied to the crank, *big* as applied to the lathe, and *sufficiently* as applied to the heating of the crank the job may seem an easier one than it does now.

Oil City, Penn. W. OSBORNE.

A Cutting Compound

Herman Jonson, on page 750, Volume 32, Part 2, describes his experience with a "patent medicine" cure-all for cutting tools; a liquid which he explains had to be diluted with twenty times its bulk of water, or possibly more, and was efficacious so long as it remained white; moreover, it readily washed or dried off the work.

From the description I have no doubt what the mystic substance consists of and I have used it myself for some considerable time with sufficient success to make the search for something better superfluous in my case. It is simply soluble creosote which you may buy over here as a much advertised patent disinfectant at about one shilling (26 cents) a pint, or obtain from the gas works at one shilling six pence (36 cents) a gallon.

I do not wish to say that the aforesaid disinfectant is soluble creosote and nothing else, but I do know that when staying on a farm this summer I found the shepherd busy annointing his flock with the dilute disinfectant as a cure for "fly." I suggested the gas works as a cheaper source and heard that the results are identical.

My own work consists chiefly in drilling and for this I think it superior to anything I have tried. I shall be glad to learn if others find it satisfactory on automatic lathe work. I have sometimes doubted if the surface finish is so good as with lard oil, but as my work does not require a high surface finish I have made no definite experiment. If not too dilute the solution protects against rust.

Leicester, England. A. C. H.

Influences of Speed on Cutting Action

H. S. Millar, in his interesting article on page 818, Vol. 32, Part 2, on the above subject, makes some reference to my cube law of cutting speeds, and suggests that this law rests on the assumption that "the durability of the tool is simply inversely proportional to the heat produced." This assumption would obviously be wrong, and was not made by me. What I did assume was, that the durability of the tool would remain unaltered so long as the rate of heat evolution was the same, and that this relation would hold good whether the given amount of heat was produced by a heavy cut at a low speed, or by a light cut at a high speed, or by any combination of cut and speed which would produce just that amount of heat.

It is, of course, open to question how far the action of the chip impinging on a tool resembles the action of a jet of water impinging on a wall. The fact is that the cube law was arrived at by assuming that the action was similar, and that the law proves to be correct when tested by the results of experiments with cutting tools.

This seems to indicate that the two actions are similar, in which case, as Mr. Millar points out, the pressure of the chip on the tool should be proportional to the square of the velocity. I was, of course, aware of the fact that this relation has not been found to exist, but there seems to be a certain lack of agreement between the results obtained by various experimenters. Doctor Nicholson shows a definite curve with a decreasing pressure, as the speed increased, whereas Mr. Taylor, after much experimenting, arrives at the conclusion that there is no traceable relation between cutting speed and pressure of chip. He also says that "within the limits of cutting speed in common use, the pressure of the chip upon the tool is the same, whether fast or slow cutting speeds are used."

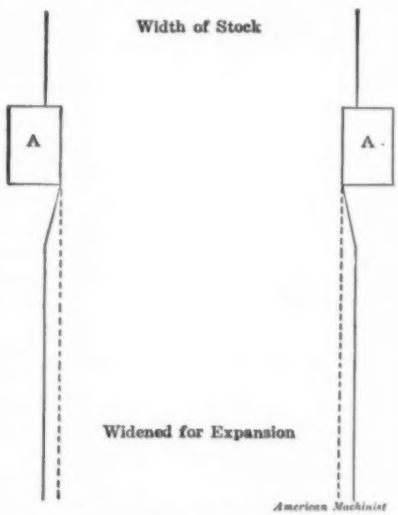
Whether the pressure is constant, or decreasing, or whether it bears no definite relation to the speed, the result is very different from what might have been expected. Probably the explanation may be found to be that there are two factors coming into play, the impinging of the metal on the tool, which should give an increasing pressure with increasing speed, and the separating of the chip from the body of the metal, which, as Mr. Millar shows, is more readily affected, and presumably requires less pressure at a higher speed. The increase in the one factor may counterbalance the decrease in the other, so as to give a nearly constant pressure, but in this case one would not expect the evolution of heat to be proportional to the cube of the speed, as it appears to be. There seems to be room for a good deal more experimenting on this subject.

EDWARD C. HERBERT.

Manchester, England.

A Register for Press Tools

I notice H. Harris on page 787, Volume 32, Part 2, shows how French pattern tools are made. May I venture to point out one or two errors? In speaking of the



A REGISTER FOR PRESS TOOLS

washer tools I described in my former article, he says, "no templet is required." A templet is of the utmost importance and the spacing off of the die he suggests is wrong as the guide plate must always be made first as all French toolmakers know. It is a common mistake to proceed with the die first. Now as to short-stroke presses, my tools can be worked in presses with any length of stroke and not leave the guide plate (this I will show in a future article). Lastly as regards jamming the stock between the guide strips, the latter can be widened as shown in accompanying cut to obviate it, as no expansion takes place between the side punches *A A*, thus leaving the

stock free to travel. I have used this type of tool for 20 years on silver, gold, german silver and steel and never found any difficulty.

O. D. CLERKENWELL.

London, England.

The Toggle Joint

I think Mr. Terhune on page 857, Volume 32, Part 2, falls into error in likening the toggle joint to a combination of levers. The beauty of the toggle joint is that the

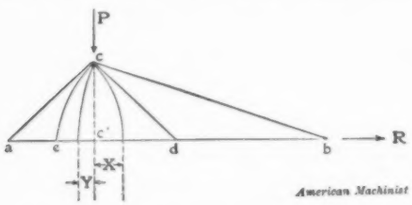


DIAGRAM ILLUSTRATING TOGGLE JOINT

resistance overcome does not bear a constant proportion to the force exerted but increases enormously as the two connecting rods approach a position where they both lie in the same straight line. If Mr. Terhune can point out any combination of levers which will give this result I think he will find that they partake of the nature of the toggle joint. Furthermore it is obvious that the equation is incorrect as it does not take into account the varying lengths of struts. For instance consider the figure given in explanation. Suppose the strut *c b* were shortened and took up the position *c d*. With *d* as radius strike the arc *c e*. Then the resistance will be overcome through a greater length as will be seen by the figure herewith, while the force *P* will still pass through the space *c c'*.

Victoria, B. C. H. C. GUNSON.

Signal Device for Shop Cranes

I note the article by F. E. Sperry on "Signal Device for Shop Cranes," on page 1090, Volume 32, Part 2. This prompts me to mention a device for the same purpose in use in the shops of the C. & E. I. R. R. at Danville, Illinois.

They have two cranes over the pits in the machine shop—one 10-ton and one 80-ton capacity, one above the other. The shop has, I think, 28 pits. They installed an annunciator system on each crane; the same as is so commonly used in hotels. On every other post, which carried the crane track, two push buttons were placed, one for each crane. These buttons were connected to the annunciator in the crane operator's cab by light trolley wires strung in parallel lines along the web of the I-beam that supported the cranes.

In this way, either crane could be called to any part of the shop by pushing the button on the nearest post. If the crane was busy the call would show on the annunciator and the operator would respond as soon as free. In the meantime, the men on the floor could attend to some other work until the crane came.

I do not know who is responsible for this device, but as the shop is well supplied with many convenient arrangements of which this is a sample, it shows a desire on the part of the management to supply equipment that will do the work in the most efficient way.

Urbana, Ill. J. H. GILL.

Machine Tool Efficiency Rating

Your correspondent A. M. Watcher, page 920, Volume 32, Part 2, hits the right nail on the head when he says, "We hope the day will come when machine tools will have an efficiency rating."

This is an idea that I have been working on for some time, first from the point of view of the "expense burden," and latterly from mechanical considerations of "duty" or efficiency. Over here the genus "practical man" is held in high honor, but on both sides of the water what he does not know about his own business is usually a very much larger quantity that what he does know. One of the things he does not, commonly, know is the conditions of maximum efficiency for any machine or any type of machine, consequently he is unable to say (truthfully that is) whether the work he is actually getting from a particular machine on a particular job is what it should be.

Again, very few people understand the large number of factors that go to the determination of the "best" type of machine for a particular class of work. Your "practical man" knows nothing about the capital investment that a machine represents, and consequent burden for interest and depreciation. He has a dim idea that one machine takes more power than another, but just how far that affects the cost of work he does not know, or even appreciate that it is often a serious question. The relative claims of milling, planing, grinding, etc., are to him merely matters of shop time and high or low wage. He knows nothing of the factors that lie behind, and often swamp questions of wage, when costs come to be correctly ascertained.

Some day cost keeping will be taken out of the hands of people with "systems" and put into those of specially trained engineers. Then it will be seen that the real problem is not that of the arrangement of bits of colored paper or card, but is inseparably bound up with the deepest and most interesting problems of the machine shop. And the solution of these problems will begin with what I term a "Production Center," that is with the machine itself. The day has not yet come when the "efficiency rating" of any tool can be ascertained off-hand, but Mr. Taylor's monumental work on cutting metals has made it possible for progress to be hoped for. The collection and publication of actual results on particular machines will be some help, but the problem contains too many elements for its complete solution by that process.

One may be excused for being amused at "Entropy's" letter, page 714, Volume 32, Part 2. Poor "Entropy." He has some very funny methods! It is lucky for him that he has a sixth sense (for checks) or it is to be feared that his habit of throwing letters into the waste basket unopened would have put him out of business long ago! But it is his growl about cost systems that interests me most. It is positively fascinating! "When we get one done, we want to know whether we made any money or not." Not a bad thing to want to know, either.

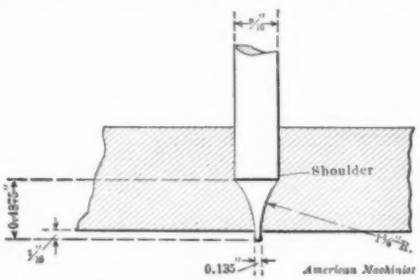
It would be quite possible to make recording arrangements that would provide a near approach to the truth, even in the conditions of which "Entropy" seems so proud. But are those conditions really necessary and reasonable? They must involve a lot of unfinished work lying about, and seem to partake a good deal of the nature of "muddling through." That looks dangerous enough, but not to be sure of what the job costs infers either that "Entropy" is very certain of himself as regards infallibility and technical efficiency, or that he has a market all to himself with big profits that will stand any amount of bad methods.

It looks as if the "Clam Digger" business was a good one.

London, England. A. H. C.

Making an Accurate Pin

At page 838, Volume 32, Part 2, A. J. Jones requests information about design-



AN ACCURATE PIN JOB

ing a pin as per sketch. I would suggest that he should put a slight shoulder on the pin to prevent sticking. This is a design used for firing pins on certain field guns of the United States army and they very seldom stick. I do not think the pins can be finished at the point in

the turret lathe to advantage, owing to the great accuracy required. I have seen similar pieces manufactured in large quantities and it was the practice to finish the point in a lathe with a forming tool, a special fixture being provided to hold them true in turning.

Yonkers, N. Y. H. L. WHEELER.

Dynamometers

Professor W. H. Rasche, of the department of drawing of this institute, called my attention to the article on dynamometers, by James W. Hughes, which appeared on page 953, Volume 32, Part 2. We both immediately agreed as to the fallacy of Mr. Hughes' conclusions and soon proved such to be the case by the result which he gives.

It seems to me just as absurd to argue as to the truths of mechanics as to argue to prove that $1 = 1$. However, there are given herewith the algebraic and geometric steps to show that the expression which is given or the pressure on the scales W', leads to the equality:

$$W' = W.$$

Fig. 1 is the projection of the system on a horizontal plane, while Fig. 2 is the projection on a plane perpendicular to the axis, $R\,R'$. A line of the figure is referred to by the two letters which represent the forces acting at the ends of that line. Therefore, line $R\,Q = z$; $W'\,Q = v$; $R'\,Q = y$; $W\,Q = x$; while the *arms* of the weights about axis, $R\,R' = L$. Of course, force $R\,R' = W$ (line $W\,W'$) $\div$ (line $R\,R'$).

Taking the line $R'W'$ as the axis of moments, we have: $R\,z = W\,x$;

or

$$R = \frac{W\,x}{z}.$$

Let

$$Q = R + W;$$

then R and W may be replaced by Q applied at the point, Q. Now taking moments about R' as origin, we have:

$$W'\,(v + y) = (R + W)\,y,$$

and

$$W' = \left(\frac{W\,x}{z} + W\right)\left(\frac{y}{y + v}\right) = W\left(\frac{x}{z} + 1\right)$$

$$\left(\frac{y}{v + y}\right) = W\left(\frac{x + z}{z}\right)\left(\frac{y}{v + y}\right) = \ldots\ldots = W\,\frac{y\,(x + z)}{z\,(v + y)}.$$

From the figure, it can be shown that the expression,

$$\frac{y\,(x + z)}{z\,(v + y)} \quad (1)$$

The triangles, $Q\,W\,W'$ and $Q\,R\,R'$ are similar. We therefore have

$$y : v = z : x;$$

and

$$(y + v) : v = (z + x) : x,$$

from which follows:

$$\frac{(y + v)}{(z + x)} = \frac{v}{x} = \frac{y}{z}.$$

Consequently

$$\frac{z\,(v + y)}{y\,(z + x)} = 1 = \frac{y\,(x + z)}{z\,(v + y)}.$$

How useless this all seems, however, when, by taking the line $R\,R'$ as axis of moments, we have as a necessary and sufficient condition:

$(R')\ (0) + (R)\ (0) + W'L - WL = 0$; or,

$$W' = W.$$

Mr. Hughes concludes the theory of his dynamometer as follows:

"The load W with its counterbalance and shaft $E\,E$ must be supported by the ball bearings $B\,B$ and $A\,A$. The spiral spring V which takes the reaction, being fixed at both ends P' and P'' can only produce pure torque, since the reaction upward at P' which tends to thrust the shaft $E\,E$ upward against the top of the bearing $B\,B$ is counterbalanced by the equal and opposite force at P'', acting downward and tending to force the shaft against the bottom of the bearing $B\,B''$."

A statement, to the effect that the forces to be dealt with here differ in *nature* from those when platform scales are substituted for the *spiral spring*, should appear preposterous to anyone who has given the subject of mechanics serious thought.

In conclusion, then, the Hughes dynamometer does not eliminate errors of *principle* attributed to other types of transmission dynamometers, for there are no such errors, in either his or the others. His dynamometer is an ingenious device and should, it seems, give reliable results.

JOHN S. A. JOHNSON.

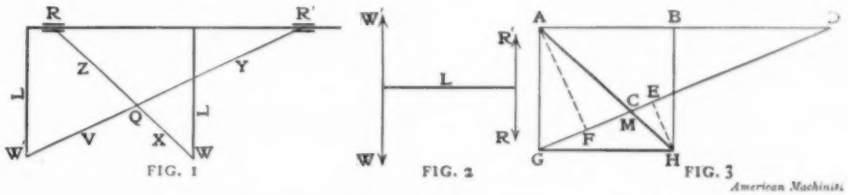
Blacksburg, Va.

In the criticism of Mr. Hughes on the usual forms of dynamometers, page 953, Volume 32, Part 2, the statements are so positive and the mathematical work apparently so straight that, at first reading it appears as if he had made a clear case against the common forms.

One or two considerations without recourse to mathematics are, however, sufficient to show the fallacy of his contentions. A shaft with two arms is arranged as in Mr. Hughes' sketch, seen Fig. 3. The application of a force at the end of one arm results in a moment of force or torque in the shaft itself, which must of necessity be the same throughout its entire length. Barring friction, no change in the reaction of the bearings can increase or decrease this torque. In the case cited by Mr. Hughes, one end of the shaft would have a torque of 50x110 inch-pounds, the other 50x100 inch-pounds, an evident absurdity.

Again, if the weight of 100 pounds be allowed to descend, it would overcome a resistance at the other end of 110 pounds *through the same space.*

If this is not convincing, we can fall back upon the well known methods of treatment and show mathematically where the error lies. The case is remarkable in that Mr. Hughes by a correct analysis and the application of correct principles



DIAGRAMS RELATING TO DYNAMOMETER ANALYSIS

of mechanics, derives an expression for the reaction at the scales of

$$R = \frac{Z}{V + Z}\left(W + \frac{W\,X}{Y}\right),$$

a correct result. The remarkable thing is that this is equal to W, itself, which can be shown as follows:

Let W be the weight, R the reaction on the scales and M the resultant of weight and reaction on the bearing at A.

Taking moments about A gives $W\ (E\,H + A\,F) = M\ (A\,F)$ *or* $W = M\,\dfrac{(A\,F)}{E\,H + A\,F}$.

From similar triangles $A\,F\,C$ and $H\,E\,C$,

$$\frac{A\,F}{A\,F + E\,H} = \frac{A\,C}{A\,C + C\,H}$$

hence

$$W = M\,\frac{(A\,C)}{A\,C + C\,H}. \quad (1)$$

Taking moments about D gives $R\,(D\,C + C\,G) = M\ (D\,C)$, from which

$$R = M\,\frac{(D\,C)}{D\,C + C\,G}. \quad (2)$$

By the condition of the problem, $A\,G = B\,H$, hence the line $G\,H$ is parallel to $A\,B$. The triangles $G\,C\,H$ and $D\,C\,A$ are similar, having vertical and alternate interior angles equal. From these triangles the proportion holds that

$$\frac{A\,C}{A\,C + C\,H} = \frac{D\,C}{D\,C + C\,G}$$

and since M is common to both equations, the result is that $R = W$.

Columbus, Ohio. W. A. KNIGHT.

From a consular report it is noted that the director of the Central Railroad of Brazil proposes to send to the United States every six months relays of four mechanics to serve in the factory of a large manufacturing concern which now furnishes the locomotives used by the railway.

Machine Tool Drive Conversions

By A. M. Britton

The electric driving of machine tools by individual motors is nowadays becoming quite general and in many cases, owing to the scarcity of room for locating the motor, calls for a good deal of skill and ingenuity on the part of the draftsman. Except in very special cases the tools to be converted are naturally of fairly old design, and reliable drawings are seldom available.

As regards my own experience on this class of work I have found out that it is not wise to trust too much to the drawings supplied by the makers, as in many cases in the bygone days alterations to the detail work have been carried out in the shops to verbal instructions and no record has been made in the drawing office.

Before setting about the task of measuring up a machine for alteration it is a wise plan to consider carefully the type of design which is to be carried out; for instance the most suitable position for the motor, whether above the machine, at either side or at the end. When the position of the motor has been settled the next step is to decide as to what type of gearing, etc., will be the most satisfactory; a summary of the different types as follows may be useful:

Types of Drive

Belt drive. This should be done without if possible, as it generally takes up a lot of space and causes a deal of dirt, besides being unsatisfactory under excessive loads. It has, however, an advantage in its "slip"; that is, when heavy shocks and reversing movements are taking place.

Chain Driving. This has the advantage of being positive, quiet-running and can be used to connect centers which are too short for a belt and too great for an idle wheel. The trouble of carrying the bearing for the latter often does away with its use. If a chain drive is employed it is both advisable and economical to provide it with a combined cover and oil trough.

Worm gearing. This is extremely useful where large reductions are required, has the advantage of being the quietest of reduction gears and also of not allowing the load to run back on the motive power. Its only disadvantage is its cost.

Bevel gears. These are all right for medium loads or slow running but under heavy loads are not advisable unless they are used in the double-helical form.

Spur gears. These are the most general and useful of all gears; have a fairly good efficiency, are cheap and up to a tooth speed of about 1500 feet per minute quiet, especially if the wheels are of steel with fine cut teeth and lagged up with well seasoned wood, driven up tight. A drive of say 4 reductions with above design will be practically noiseless. The double-helical cut wheels are naturally more expensive than the ordinary spur gear but there is no doubt that for satisfactory work the slight extra expense is quite warranted.

Friction gears. These are extremely useful where heavy loads have to be started up after the motor is up to speed, and also for light feed arrangements.

After settling the type and general idea of the drive (that is, mentally) the next step is to decide where to locate the starting switches; these should be so situated that the operator can have the motor fully under control and at the same time have a clear and uninterrupted view of the tool or any other important working part.

The next job is to make sketches of the machine, showing dimension lines which can be filled in afterward by a boy. As soon as all the sketches are finished start measuring up and have the boy jot down the dimensions; this will help to keep the sketches clean and readable.

Tools for Measuring Machines, etc.

The most useful tools necessary for measuring up can be summarized as follows: Calipers (inside and outside, large and small), 2-foot or 3-foot folding rule, 6-foot straight rule, 3-inch scale, straight-edges, plumb bob, spirit level, square, and piece of chalk. Sometimes a piece of string will be found very useful for stretching across places where a straight-edge cannot be located.

The piece of chalk may appear to be a very unimportant asset, but comes in handy when counting the teeth of gear wheels or other similar operations. An old suit, or overalls, should, of course, be worn because a great deal of time will be wasted and accuracy thrown away if you have to be careful where and how you plant yourself.

Another tip to use when measuring up is to always, that is, if possible, check over dimensions by getting them two different ways; centers of shafts especially so.

When drafting out the alterations there are numerous points to watch: Be careful that the motor is well protected by cover if there is any chance of grease or water splashing onto the commutator, brush gear, etc. At the same time don't interfere with the ventilation of the motor or else you may have trouble with overheating. Prevent, if possible (when locating the motor), the complete stripping of the machine when necessary to take out the armature. Where clutches are used the handles should be provided with locking pins.

By preference support the motor on a bracket carried from the machine rather than go to the trouble of a foundation plate and concrete; that is, of course, if the designs are mutually satisfactory otherwise. Wherever possible fix new brackets on to an existing machined surface; this will save endless trouble in setting and chipping when erecting. Where brackets are to be fixed on to the rough casting allow ample depth of chipping strips.

If you have the choice of either putting a pinion above, under, or at the side of the wheel, choose the latter because any wear on the shaft bearing does not affect the location of the pitch circles. Always aim at doing away with as much old gear as possible.

Where a flywheel is to be used, if satisfactory put it in on the first motion shaft rather than on the motor spindle, especially if the motor pinion is rawhide, the reason being to save the sudden shock through the pinion.

Be careful to keep the starting switches as clear as possible of the shop gangway to prevent anyone or anything bumping into them. Don't forget to use satisfactory locking arrangements on vibrating parts.

When deciding on the power of the motor to be used give careful consideration to the general design of the machine, especially the gearing. Many people call for high-power motors and then are afraid of using same up to full load.

Types of Motors for Various Machines

The types of motors and starting gear for use on the different types of machines can be summarized as follows:

Lathes. For main drive use shunt-wound motor with mechanical starting switch and no load release. Feed motor for shifting slides may be series-wound, about 15 minutes rated, with reversing-type controller. For the main motor in large lathes it is often advisable to use a hand-reversing, double-pole switch, so that the motion of the faceplate can be reversed if so desired. An example necessitating the use of this is when a long shaft is having a thread cut and the nut is to be run up and back again for trial as to fit.

Boring Mills. Use same as for lathes with same type of motor for raising and lowering the cross slide when too heavy to manipulate by hand.

Planer. Use a shunt-wound motor without flywheel, or better still, compound-wound with flywheel; same starting gear as for lathes, and for raising and lowering cross slide as used for boring mills.

Slotting Machines. For small machines use shunt-wound motors, but in large machines compound-wound motors are advisable.

Punching, shearing machines, etc. Use compound-wound motor with flywheel; same starting gear as for lathes.

For band saws, circular saws and wood machinery in general, also fans, drilling machines, line shafting, etc., use shunt-wound motors and same starting gear as for lathes.

Hydraulic Forging Methods

By Robert Browning

One of the great helps in making the modern automobile a commercial success was the advent of drop forging. Imagine the thousands of automobiles built every year, fitted with hand forgings—the very idea looms up before us as preposterous. Little perception is required to see that this branch of forging has attained a high position among the mechanical arts, and has prospects of further development and a wider range of usefulness in the future.

The essential features of drop forging are a top and bottom die; each die containing half an impression of the forging desired, and means of raising and dropping the top die so that the heated bar held between them can be hammered into shape. This latter is accomplished with the drop hammer.

The action produced on the heated metal, by the blows delivered by the top die is peculiar to all hammers, whether they be small ones in the hands of a man or large steam hammers. This action consists principally in stretching the surface of the heated bar more than the interior, hence the metal has a tendency to flatten under the action of the dies. At times it is with difficulty, and after the repetition of many blows that the heated bar is made to perfectly fill the impression in the dies. Herein lies the cause which restricts this useful art of forging to certain shapes, and, therefore, somewhat limits its scope.

There is, however, another branch of forging that at present is not as highly developed as drop forging, but promises soon to be as important. I refer to that branch known as hydraulic forging where with the aid of dies a piece of heated steel or iron is pressed or made to flow into the desired shape.

For the benefit of those who are not familiar with a forging press, a look at Fig. 1 will show them its construction and operation. This press is for large forgings. Most forgings made by pressing in shaped dies can be produced on a small press. The smaller the press used for accomplishing your work the greater will be the economy.

On the left of Fig. 1 is the press proper in which *A* is the operating plunger. This is pulled back after performing its stroke by plunger *B*. The platen *C* is made movable to facilitate the handling of heavy dies. The dies are secured to the plunger *A* and platen *C* by means of bolts in the tee slots. The press is usually operated by 500 pounds water pressure. When greater pressure is required the intensifier shown on the right of the drawing is used.

It differs from the drop-forging method in that the force is comparatively slowly and steadily applied. One stroke usually suffices, while in the drop-forging method bars often receive dozens of blows and frequently are reheated several times. The action or motion of the heated steel in the dies is the secret of better metal in the forgings. In Fig. 2 is shown a piece of heated round bar between two simple dies. As the top piece is forced downward, the metal flows as shown by the dotted lines. The reason it assumes this shape, instead of that of a perfect cylinder, is on account of the friction between the faces of the dies and the metal, which somewhat restricts the flow of the metal next to the faces of the dies.

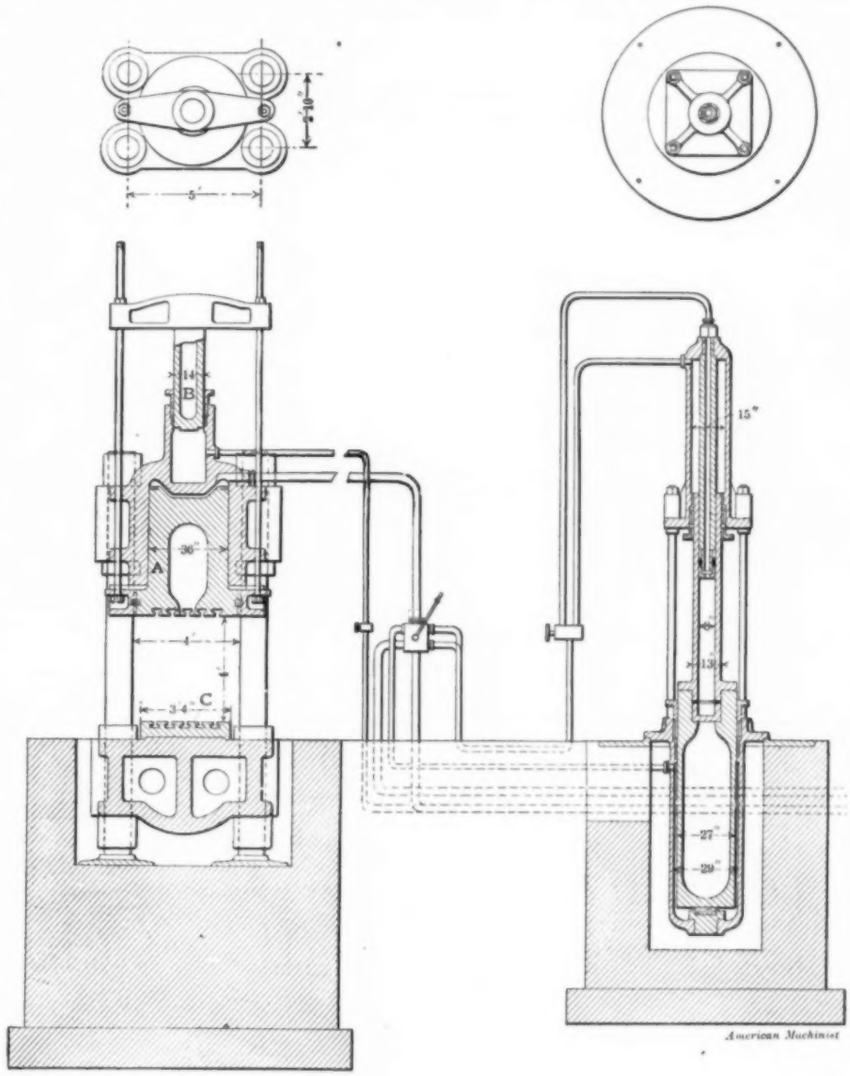


FIG. 1. SECTIONAL VIEW OF HYDRAULIC PRESS AND INTENSIFIER

By making an impression in the dies, as shown in Fig. 3, we get a different result. The ends increase in diameter on account of the impression in the dies, and thus the flow is entirely confined to the center. As the die continues to descend the central portion increases in diameter but decreases in thickness, and is gradually formed into a flange, as shown by the dotted lines.

Next let us deepen the impression in the bottom die and use a plain cylindrical top die as shown in Fig. 4. As the top die descends the metal has a tendency to flow in the same manner as in the preceding examples, but is restricted by the side walls of the bottom die. It is compelled, therefore, to flow through the open space around the top die and makes a cup-shaped forging.

By shaping the bottom die, and pointing the top die or punch, as shown in Fig. 5, you have the shape used for making projectiles. The top punch must not necessarily be circular in form, but may be square, triangular or any odd shape that does not weaken it or destroy its strength.

A good example of this is found in a patented projectile. Instead of the cavity being smooth it is ribbed as shown in

the cross-section in Fig. 6, the idea being, that on account of these internal ribs the shell will be broken into a larger number of small pieces, and thus increase its efficiency as an offensive weapon. These ribs are obtained by simply corrugating the punch, which, of course, leaves corresponding impressions in the metal.

In Fig. 7 is another example of simple forging. Hundreds of shafts with 1-inch collars are needed. Instead of machining all that metal or drawing it out under a hammer, you simply heat one end of the bar where the collar is wanted and with one stroke of the press squeeze it out as shown by the dotted lines.

These simple illustrations are merely suggestions showing the usefulness of this art in the commercial world. By a combination of different dies and several operations difficult forgings of the most intricate shape can be economically produced, and with such accuracy and smoothness that only those parts in contact with their working parts need machining.

The shapes shown in Fig. 8 are a few of the forgings that can be produced by this method. The only limit to the size of the forging is the capacity of the press used and the facilities for handling them.

From the sketches you will notice that the dies for forming the various shapes are not expensive, as they generally consist of shapes that can be produced by either a lathe or some other machine tool. Hand work seldom enters into their construction. For practically all shapes the bottom die can be made of a good grade of iron cast approximately to size, finishing only the base and the impression.

Dies of the kind shown in Figs. 4 and 5 must have a slight taper to facilitate the removal of the forging. This, however, needs to be very small as the steel immediately commences to cool, and in so doing it contracts and loosens itself. The castings used for this purpose must be solid and free from all blow holes, however small, as the great pressure put upon the steel will force it into minute holes and prevent the forging from being withdrawn.

The top die, when it has no piercing or punching to do, may also be made of cast iron, otherwise it is made of steel. A good grade of forged steel is then required, one containing between 0.60 and 0.70 per cent. of carbon has been demonstrated to give excellent results. If lower in carbon they bend and distort too readily from the great pressure. If higher in carbon they usually crack from the alternate heating and cooling of the punch, as water is turned into the dies after each operation to keep them below a destructive temperature.

Engineers who design forgings for production by this method will be wise to carefully note the following:

Make your punches practically straight, with a nice rounding at the bottom, as shown in Fig. 9. At first glance the punch in Fig. 10 would seem to require less pressure, and hence for a given pressure would give the metal a deeper punch. The reverse, however, is the ease and the reason is this: When punch No. 10 enters the metal it displaces a certain amount and this must flow upward along the side of the punch. As the punch continues to descend the area of the opening at the top of the die is gradually growing smaller, due to the taper, hence the metal must flow upward faster than the punch descends to compensate for the difference between the area of the opening and the metal displaced. This would make little difference with a perfect liquid, but creates tremendous friction with steel and greatly reduces the penetrating power of a given force.

Again, assuming that the pressure applied to the punch is downward, laying out a parallelogram of forces, we find that the resultant is divided into two forces, one acting along the face of the punch, and the other at right angles to it. The one at right angles to the face of the punch is of no value in displacing the metal, as its power is expended in jamming the metal against the sides, tending to tear the die apart. No such conditions exist with a punch similar to Fig. 9. Here the area of the opening around the punch remains the same dur-

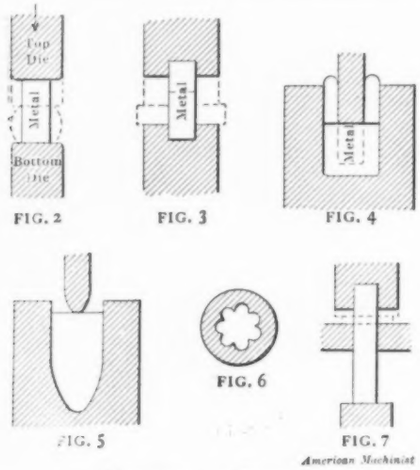


FIG. 2 FIG. 3 FIG. 4

FIG. 5 FIG. 6 FIG. 7

METHODS OF FORGING

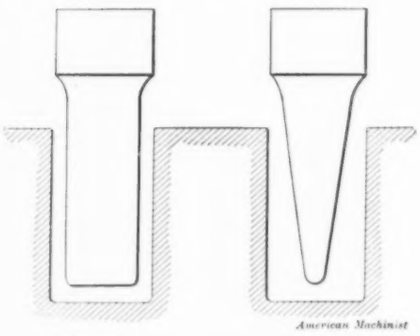


FIG. 9 FIG. 10

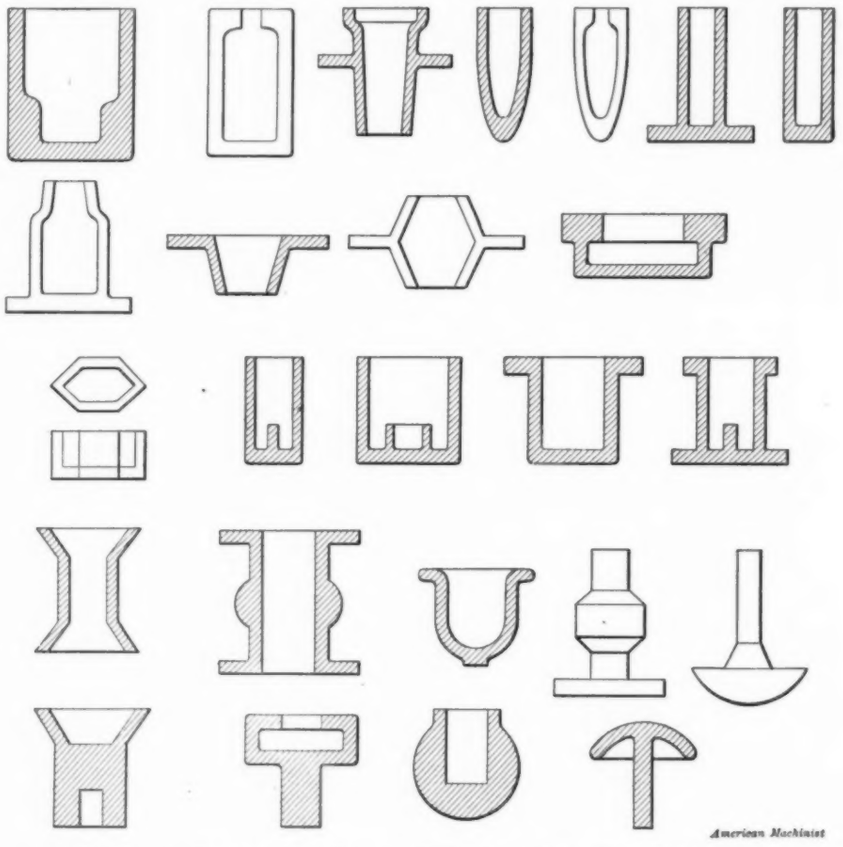


FIG. 8. A FEW OF THE SHAPES FORGED IN HYDRAULIC PRESSES

ing the pressing, and the metal flows at a uniform rate of speed as the punch descends. The force tending to tear the die apart is small compared to a greatly tapered punch.

In this class of forging it is not absolutely necessary that the dies be of one solid piece. Many forgings require them to be split, and there are cases where five and six parts were required to complete one diameter. In such instances the dies are supported by an outer casing.

The variety of metals that can be forged by this method is practically the same as for drop forging or hand forging. Wrought iron or steel low in carbon, say, from 0.10 to 0.20 per cent., is forged with the greatest facility. The grade of steel commonly known as machinery steel, ranging from 0.30 to 0.40 per cent. carbon, is readily shaped, while steels ranging from 0.70 to 0.90 per cent. carbon are forged daily in the manufacture of projectiles. Alloy steels containing either nickel, chrome or vanadium, or all three are also forged in the manufacture of armor-piercing projectiles, automobile parts, etc. The higher the grade of steel used the closer the attention required in the heating prior to forging. Steels high in carbon and chrome cannot be made to flow quite so readily.

Storing Small Castings and Finished Parts

By K. Falconer

The method of storekeeping here described was originally devised for the temporary storage of small castings and finished parts of such size as are usually kept either in boxes or on shelves or fixtures divided into spaces or bins more or less uniform in size. It was adopted as a temporary expedient to overcome delay in building fixtures for a new store room which had to be used some weeks earlier than had been anticipated. It was found so satisfactory that it is now largely used for the storage of some lines of stock as well as for those articles for which it was originally intended. The success of the plan depends largely on a careful laying out of the floor space, and care in determining the sizes of boxes to be used.

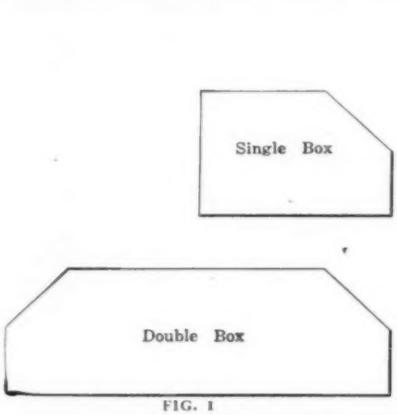


FIG. 1

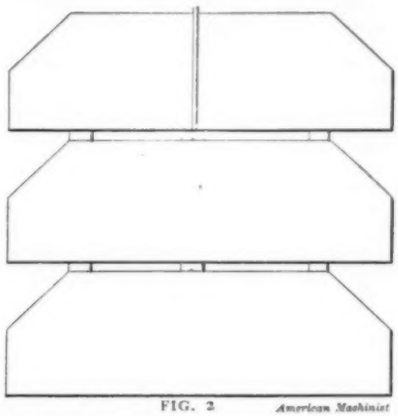


FIG. 2

American Machinist

STORING SMALL CASTINGS AND PARTS

The floor space was marked off as though for fixtures 30 inches in width and in length any multiple of 12 inches, with the necessary width between for passage ways. Fig. 1 is a side view of two boxes, the single 15-inch and the double 30-inch outside measure; the double box, it will be seen, is the same shape and size as two singles placed back to back. Fig. 2 shows a stack, the boxes composing it are not placed directly on each other but are separated by strips 1x3 inches placed longitudinally. The bevel in the front of the boxes slopes from a point half way up the front to a point 5 inches back—thus two-thirds of the area of the bottom is on solid supports; the remaining third being practically only half depth, five-sixths of the entire weight is thus supported directly from the floor. In the particular instance under consideration both the single and double boxes were made in 12-inch and in 24-inch widths.

The advantages obtained, in addition to economy, were found to be the great facility with which the stores could be rearranged as new lines or sizes were added, this resulting in a more orderly and logical arrangement facilitating handling, and a great saving of time and labor at stock taking.

The method by which the latter end is attained in regard to those goods priced by weight is as follows: The different sizes of boxes are known as A, B, C and D. They are, of course, made up at different times and possibly bought from different makers; each lot is given a number and when they are received each box is branded with the lot number and a letter indicating the size; thus A3 means the third lot of size A. Some days before stock taking a number of boxes (sufficient to establish a fair average) bearing the same letter and lot number are weighed and the average assumed to represent the weight of each. When the actual taking of stock begins the contents are not removed but weighed with the box and the weight of the latter deducted.

Sufficient space was left at one end of the storeroom for an additional fixture, as the stacks or boxes are called. When taking stock the boxes in the first fixture were rebuilt in this space, all the stacks being similarly moved when the weights were taken. When the boxes were all weighed they were thus all in regular sequence but the exact reverse to their former position, to which they were returned as opportunity offered.

Though not so evident the saving in time in taking an inventory of parts which have to be counted is also considerable. In such cases the contents are put into another box as they are counted and a new stack built as previously explained. This can be done much more quickly than if they have to be taken from a bin or pigeon hole and replaced in the same space.

Rapid Bridge Building

Apart from its importance as an engineering feat of the first order, the Manhattan bridge, across the East river, New York, which was formally opened on December 31, 1909, is a noteworthy achievement in point of the rapidity with which the steel superstructure has been erected, and the fact that its completion and opening occurred on exactly the date specified by the engineers in charge more than a year ago. As our readers will recall the bridge is 6855 feet long, end to end of approaches, and has the third longest suspension-bridge span, 1470 feet, in the world, being exceeded only by the central spans of two other bridges across the same river, the Brooklyn bridge with its 1595½-foot span and the Williamsburg bridge with its 1600-foot span. The erection of the steel towers was commenced in June, 1907, about 2½ years ago. The towers were completed in July, 1908. The first wire for the cables was pulled across the river on August 10, 1908, and the last of 37,888 wires on December 10, 1908. The erection of the suspended superstructure was begun on February 23, 1909, and finished on June 1, 1909.

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An Educational Discovery

The article in another column on co-operative education at Fitchburg points out the fact that alternate weeks devoted to school work are found to be just as effective, when judged by the progress made by the pupils, as full-time work under ordinary circumstances—an experience which exactly parallels that found by Professor Schneider at the University of Cincinnati. This experience is referred to as not at all unreasonable when all of the circumstances are considered, but like many things which seem reasonable enough when once made plain, this is none the less a discovery of the first order of importance.

Entirely apart from the industrial feature of the work, the bare fact that the boys accomplish as much, or, if you prefer, nearly as much as those who devote their entire time to their books, shows that, in adopting the coöperative plan, the school authorities are sacrificing nothing to the demand for trade teaching. When, indeed, we consider that the plan has already reclaimed some to school, who would have otherwise abandoned it, that this result is immediate and before the plan has had a chance to have its importance realized by the public, and that this effect is fairly certain to increase in large measure as the plan comes to be looked upon as a regular feature of our school system, it will be seen that the opportunities of the public schools are actually and largely increased by the increased attendance upon the high schools which the system will bring about.

In addition to solving the problem of industrial education the plan thus bids fair to go a long way in solving the great problem of the educator, that is, the retention of boys in school beyond the compulsory school age. When we add to this the fact that it solves the additional problem of the educators, to which they are keenly alive, that is, the introduction of vocational training into the public schools and the identification of those schools with the industrial life of the nation, it would seem that the educators can scarcely fail to recognize that the plan offers to the public schools the greatest opportunity which is now before them.

Many have criticized the coöperative plan as giving more time to school work than the training of mechanics requires, and if we look upon mechanics as such only, the criticism is, no doubt, a sound one. At the same time, the division of the time on any other than a half-and-half basis seems scarcely feasible and right here lies the opportunity of the educators, in that the plan gives opportunities for training in citizenship and general intelligence which they now lose through the withdrawal of the great majority of boys from school at an early age.

It only remains to be seen if further experience justifies the conclusion now based on the Cincinnati and Fitchburg experiments. It is only reasonable to recognize that some caution is necessary in basing a general conclusion upon the Cincinnati experience, because of the fact that the boys enrolled in the coöperative course at the University of Cincinnati are a picked lot, the selections being far more drastic than in any other institution of learning in the country, and, for that matter, in the world, and that, moreover, these boys are under a peculiar pressure to demonstrate the metal of which they are made. While, in general, the selections elsewhere can scarcely be as drastic as they are at Cincinnati, nevertheless they will always be sufficiently drastic to secure a body of pupils who are distinctly superior to the average, and we believe that future experience will be little, if any, less favorable than that already accumulated.

Variety is the spice of life, and to none so much as to those of school age. There has never before been an opportunity to demonstrate the value of this factor in education, although "the whining school boy creeping like snail unwillingly to school" has long been a standard quotation. To just what extent the relief of the monotony of steady school work would operate could not have been predicted and few would have expected as large results as those which have been obtained. When the attitude of the large majority of boys toward their books, due largely to the fact that, so far as they can see, most of the book work has no definite aim and leads nowhere, is remembered, we consider that the stimulating effect of the removal of this condition, combined with the introduction of the element of variety in the boys' life, is certain to have large results, and we are quite prepared to believe that future experience will not differ much from that to which we can already refer.

While the educational authorities are profoundly aware of the shortcomings of the public schools, as shown by their continued discussion of the subject,

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During 1909 *we printed and circulated* 1,209,000 *copies of the* AMERICAN MACHINIST.

Our circulation for December, 1909, *was (American weekly, American monthly, English weekly and German weekly)* 135,750.

January 6	41,250
January 13	30,500
January 20	22,500

This paper reaches 41,250 *separate readers each month and* 22,500 *each week.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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much of this discussion has been little more than aimless floundering in the dark, and while it has been in the highest degree creditable to the ambition of the educators to meet the situation, it has been scarcely creditable to their grasp of it. They now have a foundation on which they can build, and we hope, and believe, that the period of discussion will soon be followed by a period of fruitful action.

French Duties under Old and New Tariffs

The French Chamber of Deputies has voted a new tariff that will probably come into effect in a short time. The accompanying table gives the old and new rates for metal articles more particularly interesting the machine-tool industry and particularly exported from the United States. The first column gives the minimum tariff rate paid by *all* European countries except Portugal. The second gives the maximum tariff rate paid on American products; these two columns apply to the old tariff now in force. Column three gives the revised minimum tariff rates applicable to products of European countries. Column four gives the revised maximum tariff rate applicable to American products.

TARIFF RATES PER 100 KILOGRAMS.

	Old Rates.		New Rates.	
	Minimum.	Maximum.	Minimum.	Maximum.
	Francs.	Francs.	Francs.	Francs.
Machine tools weighing:				
More than 15,000 kilograms	10	15	10	15
5,000 to 15,000 kilograms	10	15	12	18
1,000 to 5,000 kilograms	10	15	16	24
250 to 1,000 kilograms	16	20	24	36
250 kilograms and under	50	70	50	75
Scroll, band and circular saws	22	27	35	53
Files and rasps:				
Length 35 centimeters (14 inches) and over	22	27	30	45
Length 35 centimeters (14 inches) and under	22	27	40	60
Vises, stocks, ratchets, bit braces, breast drills, wrenches of all kinds weighing each, net:				
15 and more kilograms	22	27	15	25
3 to 15 kilograms	22	27	25	38
3 kilograms and under	22	27	35	53
Mechanics tools: Drills, taps, dies, reamers, milling cutters in one piece, with largest cutting diameter of:				
25 millimeters and over	22	27	50	75
10 to 25 millimeters	22	27	100	150
10 millimeters and under	22	27	150	225
Shearing blades: turning, planing, mortising, nurling, reaming and lathe tools; reamers and milling cutters with blades separable	22	27	40	60
Other tools	22	27	25	33
Chains, iron or steel:				
Link diameter 15 millimeters and over	8	12	8	12
Link diameter 8 millimeters to 15 millimeters	8	12	12	18
Link diameter 8 millimeters and under	8	12	16	24
Rivets, screws:				
25 millimeters and over	14	20	10	15
18 millimeters to 25 millimeters	14	20	12	18
12 millimeters to 18 millimeters	14	20	14	21
8 millimeters to 12 millimeters	14	20	18	27
3 millimeters to 8 millimeters	14	20	24	36
3 millimeters and under	14	20	28	42
Household and all articles not specified of iron or steel:				
Not polished nor painted	14	17	17	26
Painted, polished, galvanized	16	21	18	27
Varnished	18	24	20	30
Enameled, tinned	25	30	38	42
Coppered and painted, tinned and varnished	25	30	30	45
Copper tools, alloy of copper and tin	20	35	30	4
Measuring tools: Micrometers, calipers, graduated rules, gages, etc.			300	450

The Abuse of Portable Tools

There is one leak in the expense for the upkeep of tools that ought to be capable of substantial reduction with a little care on the part of those in charge of the men and tools. We refer to such portable tools as air hammers, drills, riveters, etc., which are used in large numbers in structural or tank work and which represent a large outlay in many places.

Knowing the cost of such tools, it is little less than distressing to find them dragged around the yard by a long line of hose, bumping over all kinds of obstructions, falling into pits and being otherwise abused, without regard to the fact that they are rather delicate machines and cost money to buy and maintain.

In tank or structural work it is no uncommon sight to see a husky individual stand on a scaffold, grasp a hose several feet from the tool, swing it back and forth until it gets enough momentum to be swung up over a tank or framework and drop with a crash on the other side.

Builders of these tools have provided for this treatment so far as possible, making them with heavy cases and furnishing protection as well as they can, but nothing will stand this treatment for long and the repair bills are very heavy.

Perhaps the great saving over hand labor is considered enough to offset these repairs, and the difference in labor cost between the class of men who handle them with no regard for their mechanism, is cheaper than to hire a better class of men for this work. But the fact remains that a large waste, and one that seems mostly unnecessary, is constantly going on and if a "penny saved is a penny earned," this seems a good opportunity to save it.

Personals

Items for this column are solicited.

W. J. Green has recently returned to Pittsburg, having associated himself with the Van Dorn Electric and Manufacturing Company.

C. J. Morrison, until recently connected with the Emerson Company, has opened an office in New York City to engage in efficiency engineering work in his own behalf.

Hans Renold, of Manchester, England, inventor and manufacturer of the "silent" chain, under whose patents the Link-Belt Company manufacture in the United States, is at present in this coun- for a few weeks' business stay.

J. M. Flannery, general manager, and George E. Lees, advertising manager, of the American Vanadium Company, Pittsburg, Penn., sailed on January 10 for a five weeks' trip abroad, during which period they will cover England and the Continent.

M. M. Pharo, formerly general manager of the Thousand Island Boat and Engine Company, Morristown, N. Y., has recently accepted the position of superintendent of the automobile engine department of the Seager Engine Company, Lansing, Mich.

F. F. Prentiss, president of the Cleveland Twist Drill Company, recently resigned his position, due to ill health. Mr. Prentiss is succeeded by J. D. Cox, who was founder of the firm, and up to now has always looked after the practical end of the business.

J. W. Coyle, formerly master blacksmith of the Lehigh Valley railroad, and more recently in charge of the drop hammer and machine department of the Reading Railroad shops at Reading, Penn., is now with the Rockwell Furnace Company, New York City.

F. A. Halsey, editor of the AMERICAN MACHINIST, sails today on the steamship "Arabic" for a cruise to the Mediterrean and the Orient. Mr. Halsey expects to be gone about three months, and before returning expects to visit some of the important industrial centers of Europe.

NEW TOOLS and MACHINE SHOP APPLIANCES

Showing New Ideas in Machine Shop Equipment that make it possible to do better work at a reduced cost

Substantial Lathe Tools for Manufacturing

The lathe tools shown herewith have been recently brought out by the G. R. Lang Co., Meadville, Penn.

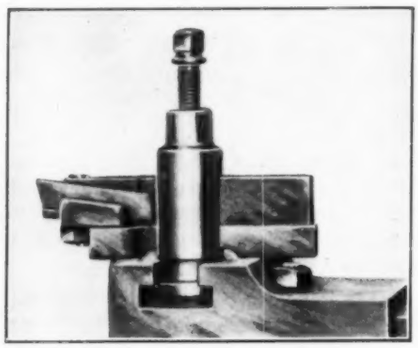


FIG. 1. RIGID TOOL BLOCK

The solid block in Fig. 1 is intended to be used on lathes using the swivel tool post instead of regular ring and shoe. It gives a more solid bearing for the tool than is possible with the adjustable shoe and it is quite as handy to use because

FIG. 2. LANG CUTTING-OFF TOOL

our cutters are always ground on the end to resharpen, and the cutter advanced forward as necessary so that the cutting edge of the tool is always practically the same hight. This is not the case with a solid tool, which is constantly being ground on the tool as well as the front, and naturally wears lower on the cutting point. This saves the time which is usually spent by the operator in adjusting his tool up and down until it cuts properly. As these tools are used for turning and also side facing, and as the cutting-off tools, which are illustrated in the other cut, are the same hight as the turning tool, this block answers for practically all operations in manufacturing. As the cutter is ground away and becomes shorter and is advanced up, the tool holder itself can be slipped back closer to the tool post.

Any new or improved machine or shop appliance of interest to our readers will be illustrated and described in this department —the machine-shop news.

A full and detailed description —the device featured—when of special interest and it can appear here before being sent elsewhere.

ALL descriptions appear in all four editions of the paper—Weekly, Monthly, Weekly English and Weekly German.

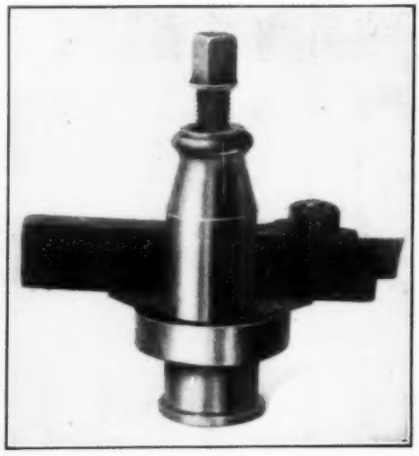


FIG. 3. THE OTHER SIDE

The cutting-off tool, in Figs. 2 and 3, is made to cut as freely as a properly forged tool. The top and bottom of cutter are perfectly flat as it has been found unnecessary to make these angular in order to hold the cutter rigid. The method of clamping insures the cutter being rigid with the holder, which is very essential on a cutting-off tool. The cutter is placed at the proper cutting angle so that it is not necessary to groove out the top in order to make a free cutting tool. The cutters are beveled from the top toward the bottom as usual and are made from standard-size steels as furnished from the mill in bar lengths. These cutters are so rigid that they can be used for threading, on small work, to good advantage. These are made in three different sizes at present: ½x1, ⅝x1¼ and ¾x1½ inch.

An Electrical Tachometer

High-speed steels and well established cutting speeds make it imperative to know that machine tools are running at their proper rate. To provide a sensitive and yet nonvibrating tachometer that may accurately indicate at a distance, as, for instance, in the superintendent's office, just how fast the machinery of a shop is running, has led to the development of the Hutchinson electrical tachometer, herewith illustrated.

As seen, this device consists of a magneto driven by a silent chain, from the shaft whose speed is to be determined. The magneto is of the automobile type, that is, with stationary permanent field magnet and a stationary armature coil, between which soft iron conductor pieces rotate, generating an alternating current. The voltage generated is directly

AN ELECTRICAL TACHOMETER

proportional to the speed of rotation, and this is read on a special voltmeter calibrated directly in revolutions per minute of the shaft. The use of alternating current does away with all commutators and brush contacts which have hitherto caused uncertainties in the readings of electrical tachometers.

For marine use, which is one of its broadest fields, twin magnetos driven at the same speed furnish two currents; one from one side to the moving coil of

the indicator and one from the other side to the stationary coil. For rotation "ahead" these alternating currents are in electrical phase and the reading is on the "ahead" side of the scale. For reverse or "astern" rotation, one magneto rotor slips back 90 degrees, throwing the alternating current impulses from the two magnetos out of phase by 180 degrees. This reverses the motion of the indicating hand so that it reads on the other end of the scale, thus showing reversed rotation as well as revolutions per minute.

By interposing a small but heavy flywheel on the magneto shaft and driving through two oppositely coiled flat springs instantaneous variations in angular velocity of the engine shaft during a single revolution are smoothed out so that the indicating hand does not vibrate.

Another advantage of this device is that as many voltmeter speed indicators may be installed as desired, so that the information may be before as many men in as many different places as necessary. It is manufactured by the Industrial Instrument Company, Foxboro, Mass.

Compressing Steel Tires Cold

The illustration shows an extremely large, cold tire-setting machine, recently built by the West Tire Setter Company, Rochester, N. Y., for shipment to the Argentine Republic. It is of general interest, both on account of its size and the somewhat unusual work that it performs. This machine will take in tires 9 feet 3 inches in diameter and from that down to 30 inches by the use of blocks which are interposed between the outside rams and the wheel to be operated on.

The machine measures a little over 11 feet in outside diameter and contains 18 hydraulic rams, each capable of exerting a pressure of approximately 100 tons, with a pressure of 2000 pounds per square inch from the pump. The base consists of a single casting, weighing 7000 pounds; and the large outer rings surrounding the hydraulic rams are of steel, weighing approximately 4000 pounds. The whole outfit, as indicated, weighs very nearly 50,000 pounds.

The tires are made enough larger than the wheels to be easily dropped into place cold and as the rams force the dies toward the center, the tire is compressed from all points and forced down onto the wheel by a continuous process of upsetting, which takes place all around the tire. This machine will set a tire 6 inches wide by 1½ thick, which means a compression of an endless band of steel having a cross-section of 9 square inches.

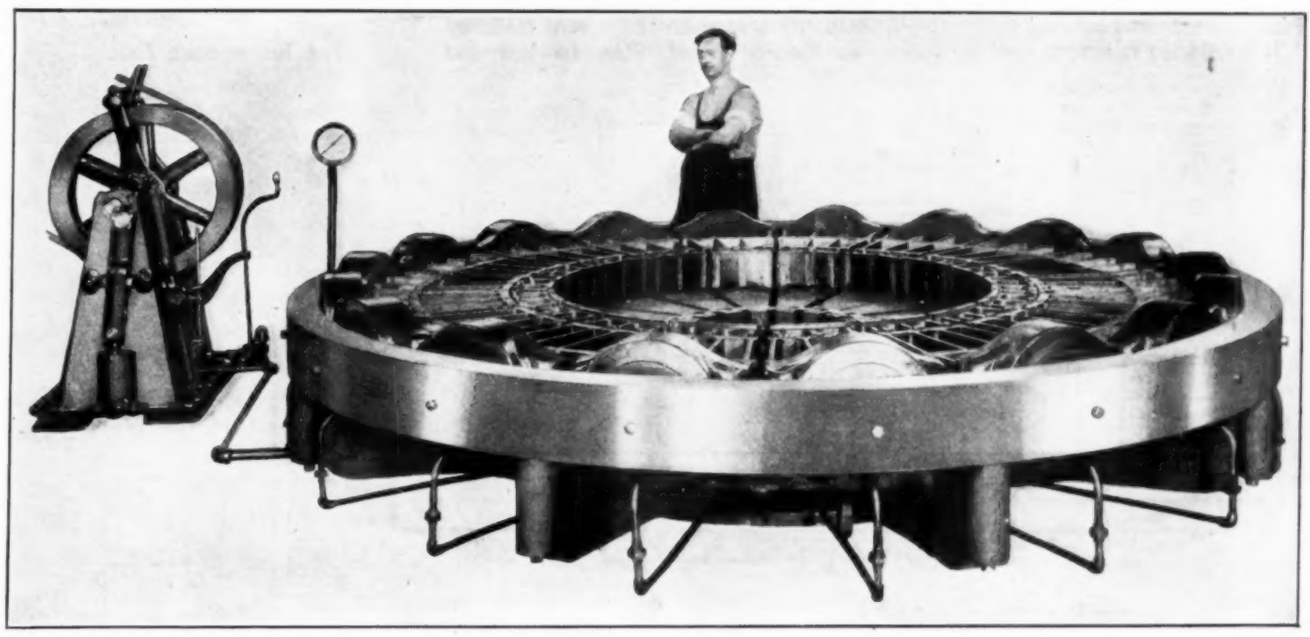
The pressure required to compress a tire 5 inches wide and ¾ thick, in a tire 6 feet in diameter, is approximately 50 tons pressure on each of the 18 rams or 900 tons, and a tire of this section and size could be compressed sufficiently to reduce the circumference from two to three inches if made of the ordinary grades of tire steel. The soft-iron tire might be compressed more than this, before reaching the limit, which is when it commences to kink sideways.

The thinner the tire the less it can be compressed before having a tendency to buckle, so that very thin tires must be welded nearer the correct size than large tires. In the case of automobile rims they have secured the best results by rolling the rims from ⅛ to 3/16 inch larger in diameter than the required finished sizes and then compressing to the finished size on one of these machines.

The amount of pressure required to compress an ordinary automobile rim for a 4-inch tire would not exceed 15 tons pressure for each ram, or 270 tons on the whole rim.

It will be readily understood that any tire or rim to be successfully handled in this way must be made large enough so that it can be compressed beyond the elastic limit of the material before it is brought to the required size. For, if it is only compressed to the elastic limit it would immediately assume its original size as soon as the pressure was removed, so that the amount of compression required to give a permanent set depends on the elastic limit of the metal being worked.

Tests indicate that the metal is densified during this process of compression and that tires which have been so compressed will stand a higher tensile and transverse strain than before. This is borne out by a test at the Woolwich arsenal, England, where it was first feared that the upsetting of the metal in this way would so injure the material that it would be practically worthless for use, but a report signed by Lieutenant-Colonel G. F. Clarke, given after using the machine for eighteen months, indicates an improvement in the material due to this compression.



A Machine Which Will Set a Heavy Steel Tire 9 Feet 3 Inches in Diameter, Without Heating

Building a Lathe without Machine Tools

By Alfred Carman

I have read in the American Machinist of many difficult jobs that have been accomplished by machinists. I will try to describe a little job done by an amateur machinist, which presented many difficult situations on account of its being done outside of a machine shop, and without the use of any machine tools at all, this job being the building of a lathe that swings 5 inches and takes 18 inches between the centers.

I will not attempt to describe the entire job, but will confine myself to the more difficult points.

The tools or jigs, shown in the accompanying drawings, accomplished several of the operations satisfactorily. Fig. 1 is a front and end view of the lathe bed and the jigs used in drilling the holes for the spindles in headstock aad tailstock.

A are ways made of two pieces of machine steel filed to the proper shapes and finished by scraping. *B* are cast-iron blocks, one at each end of the bed acting as spacers for the ways *A*. *C* is a front view of part of the headstock. *D D* are two cast-iron pieces bolted to the bed of the lathe and connected at the top by a tube *E* in the manner shown. This tube, ½ inch inside diameter, is of soft steel, case-hardened at each end.

It is adjusted to line up with the slides V's in the head and tailstocks and saddle of the tool carriage. *A* is a piece of machine steel 2x½x14 inches with four slotted holes to admit bolts to hold the adjusting blocks *B*. *C C* are the cutters held in position by the screws *D*.

The V's were cut by holding the castings in a vise and drawing the tool over them in the same manner that a draw knife is used.

The drawing shows part of the headstock at *E* and the manner of cutting slots. The job was started with the cutters making a mere scratch, the cutter being advanced as the work progressed. The slots were finished by filing and scraping.

The screw which operates the cross feed was made of 5/16-inch machine steel with a ½-inch space on the back end turned down to 7/32 inch. To turn this to proper size the tool shown in Fig. 3 was made.

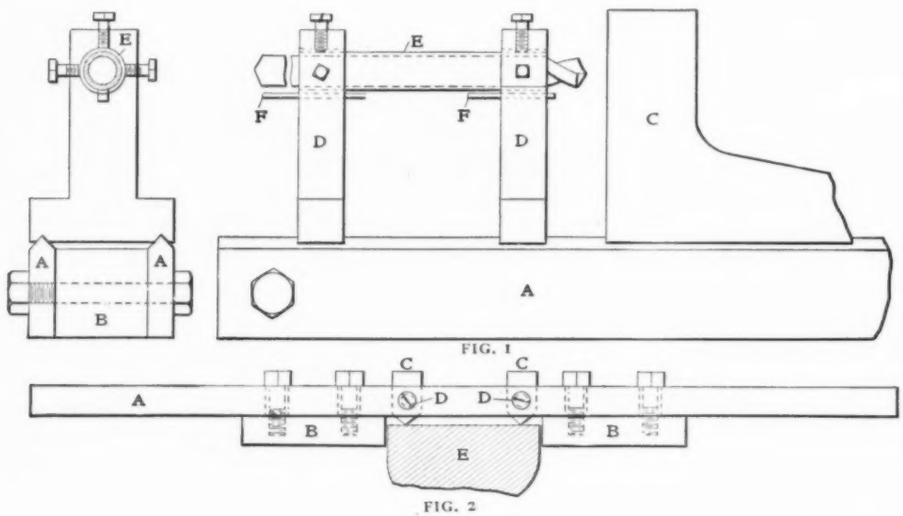
A is a piece of 1-inch square machine steel and forms the body of the tool. *B B* are the straps and bolts, holding the cutter *C* in proper position in front of the hole *D*. This job was done by holding the piece of steel *E* in a brace just as a bit is held, inserting it in the hole *D* and turning. The tool carriage was made of flat pieces of machine steel filed to shape and finished by scraping and put together with screws.

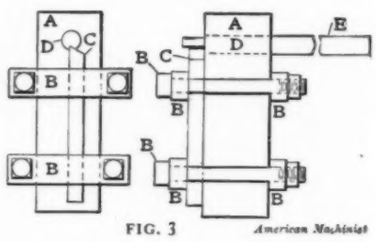
The rack and gears which operate the tool carriage, the spindles and centers, and the bronze bearings were made by an obliging friend. The handles and toolpost were simply makeshifts and were used until better ones could be turned on the lathe itself.

This lathe, though small, is not a toy by any means and does accurate work within its range.

Taking in consideration the time expended on this work it will readily be seen that economy was not the object in view, but I delight in overcoming difficulties and can experience a lot of satisfaction in saying, "I built it!"

Not being employed at machine work I have found the American Machinist a great help to me in undertaking a job like this, and I am very grateful for much valuable information I have gained in reading its pages.



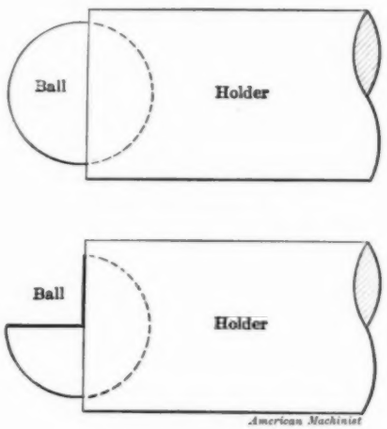


'Building a Lathe Without Machine Tools

A Round Nose Tool

By A. W. Green

A very satisfactory round-nose tool for lathe or drill work can be made from a hardened-steel ball. Select the size of ball for the groove or ball race wanted. Soft-solder it into the end of the lathe tool, grind it to the center and stone it for clearance. Use it carefully and you have a tool that will produce the circle desired without question. By heating the holder there can be no danger of drawing the temper of the ball.



A Round-nose Tool

INCREASING · SHOP · CAPACITIES

where More Tools will be needed

Sherron Brothers will erect a tile factory in West Marion, Ind.

The Morton Brick Company, Morton, Minn., will erect a $10,000 addition.

Swift & Co., Jersey City, N. J., will build a large addition to its refinery.

The Wood Drill Works, Paterson, N. J., will increase the capacity of its plant.

The plant of the Bath (Penn.) Hosiery Mill was burned. Will be refitted.

The Tide Water Power Company, Wilmington, N. C., will erect a repair shop.

The Bard Union Company, Norwich, Conn., has purchased site for a new plant.

The Iten Biscuit Company, Omaha, Neb., will build a new $150,000 factory.

The Narrow Fabric Company, Allingtown, Conn., will put up a new building.

The Barnes Drill Company, Rockford, Ill., has purchased site for a new plant.

The Sebastian Lathe Company, Covington, Ky., will erect an addition to its plant.

The Grant Iron Works, Houston, Tex., will erect a $35,000 addition to its plant.

The Consumers Brewery Company, Philadelphia, Penn., will enlarge its plant.

The Sheboygan (Wis.) Light, Power and Railway Company is to enlarge its plant.

The Germain Piano Company, Saginaw, Mich., will install three additional boilers.

The Baltimore & Ohio Southern Railroad will build a new machine shop at Garret, Ind.

The Michigan Paper Company, Plainwell, Mich., is having plans drawn for a new mill.

The Canton (Ohio) Drop Forging and Manufacturing Company will build an addition.

The Sante Fe Railroad has commenced work on the new roundhouse at Cherryvale, Kan.

The plant of the McWane Pipe Foundry, Lynchburg, Va., recently burned, will be rebuilt.

Fire caused $50,000 damage to the plant of the Gold Coin Stock Company, Minneapolis, Minn.

The Adolph Leitelt Iron Works, Grand Rapids, Mich., will build an addition to its plant.

The C. Reiss Coal Company, Sheboygan, Wis., is planning the erection of a new power house.

The Leathers Handle Factory, Dickson, Tenn., recently destroyed by fire, is being rebuilt.

The Rock Island Railroad will rebuild shops at Shawnee, Okla., recently wrecked by explosion.

The Castle Kid Company, Camden, N. J., will erect two additional buildings to cost $75,000.

William Rahr Sons Company, Manitowoc, Wis., will erect a $250,000 addition to its brewery.

The Willimantic (Conn.) Gas and Electric Light Company will install turbine engines in its plant.

The Ellery Twist Drill Company, Portsmouth, N. H., will double the capacity of its plant.

The Bowling Green (Ky.) Railway will erect carhouse and repair shop. H. D. Fitch, president.

R. E. Findlay, Macon, Ga., will establish a brass foundry. Is in the market for equipment.

The H. J. Heinz Company is erecting a new power house at its bottling plant in Sharpsburg, Penn.

The Grand Forks (N. D.) Foundry and Machine Company will increase the capacity of its plant.

The Olds Gas Power Company will erect a two-story machine shop at its plant in Omaha, Neb.

C. Hager & Sons Hinge Manufacturing Company, St. Louis, Mo., will erect a factory to cost $25,000.

The plant of the Niagara Falls (Ont.) Milling Company was destroyed by fire. Loss, about $50,000.

The Fisk University, Nashville, Tenn., will install a heating and lighting plant to cost about $50,000.

Fire caused $50,000 damage at the plant of the T. C. Richards Hardware Company, Winsted, Conn.

The Neverfail Wind Mill Company, of Kansas City, Kan., may locate a factory in Springfield, Mo.

The Smith & Winchester Manufacturing Company, South Windham, Conn., will install a water wheel.

The American Knitting Company, Waltham, Mass., is erecting a building for the manufacture of yarns.

The Fairmont Creamery Company, Omaha, Neb., will build a two-story addition for a cold-storage plant.

The Worden-Meeker Company, Alameda, Cal., will erect three additional buildings at its varnish plant.

The plant of the J. D. Connell Iron Works Company, New Orleans, La., was burned. Loss, about $50,000.

Fire destroyed the coal-hoisting apparatus of the Kanawha Fuel Company, Milwaukee, Wis. Loss, $15,000.

Work has commenced on a five-story factory building for the Clark Knitting Company, Grand Rapids, Mich.

The Denver & Rio Grande Railroad is to erect a new roundhouse in Colorado Springs to cost about $10,000.

Techow & Loucks, Panuco, Dgo., Mexico, will install a new or second-hand gas engine to operate their mine hoist.

The Lucia Mining Company, Gabriel, Dgo., Mexico, expects to build a concentrating and cyanide plant within a year.

The plant of the Ruleville (Miss.) Light, Ice and Coal Company, recently burned, will be rebuilt on a larger scale.

Spang, Chalfant & Co., Sharpsburg, Penn., are preparing to erect a new power house and electrical equipment building.

The Houston (Tex.) Structural Steel Company will build an addition to its plant and treble its present capacity.

W. T. Letts Box & Cooperage Company, St. Joseph, Mo., will erect a plant for the manufacture of boxes, shooks, etc.

The Windham Manufacturing Company, Willimantic, Conn., making cotton goods, will enlarge its mill in the spring.

The Avino Mines, Ltd., Gabriel, Dgo., Mexico, expect to build a new concentrating plant at the Avino mine within a year.

The Pine Beach Improvement Company, Hale building, Philadelphia, Penn., will erect a power plant at Pine Beach, N. J.

The Philadelphia & Reading Railroad has purchased site in Harrisburg, Penn., on which a freight warehouse will be erected.

The asphalt plant of the Parker-Washington Company, Muskogee, Okla., was destroyed by fire, causing a loss of about $10,000.

Fire destroyed the main building of the Oriental Metal Bed Company, Hoboken, N. J. Loss, about $210,000. Will be rebuilt.

The Rockford (Ill.) Punch and Manufacturing Company, recently formed, will establish a plant for manufacturing shop tools.

The Ohio Malleable Iron Company, Columbus, Ohio, controlled by the Jeffrey Manufacturing Company, is erecting an addition.

The Roxford Knitting Company, Jefferson and Randolph streets, Philadelphia, Penn., is having plans drawn for a six-story addition.

The Millville (Penn.) Water Works Company will let bids in the near future for new electrical equipment for commercial lighting.

The Etna (Penn.) Water Works, lately destroyed by fire will be rebuilt. New pumping and electrical equipment will be installed.

The E. A. Thomas Auto Company, Buffalo, N. Y., is putting up an addition to its machine room. Equipment not yet fully decided on.

Kneeland, Buel & Bigelow, Bay City, Mich., have prepared plans and specifications for four new boilers to be installed at their lumber mill.

Bigelow & Spring, Tampa, Fla., will erect an addition to their machine shop, install brass foundry and construct drydock and shipyard.

The Owen Motor Car Company, Detroit, Mich., recently organized, has purchased site for factory. The company is capitalized at $300,000.

A. J. Brady, care Southern Railway, 299 Broadway, New York, is in the market for equipment for the manufacture of washing machines.

The La Grande (Ore.) Manufacturing Company, lately incorporated, will establish a plant for the manufacture of agricultural machinery.

The Strable Manufacturing Company, of Saginaw, Mich., will need woodworking machinery for a new flooring factory at Nashville, Tenn.

The Crystal Ice, Cold Storage and Canning Company, Ocala, Fla., whose plant recently burned, with a loss of $100,000, will probably rebuild.

W. G. & S. V. Muckenfuss, Spartansburg, S. C., are erecting a new factory for the manufacture of brooms to replace one recently burned.

The August Feine Wrought Iron Works, Buffalo, N. Y., has bought site on which a plant for the manufacture of structural steel will be erected.

The Northern Pacific Railroad, St. Paul, Minn., is said to be preparing plans for a foundry at Brainerd, Minn., which will cost about $125,000.

Engineer J. V. Poley, Royersford, Penn., is preparing plans for a boiler house and an addition to the plant of the Century Knitting Company, Spring City, Penn.

The Marble Falls (Tex.) Cotton Mills Company, recently incorporated, plans to install 400 looms, using electrical power. The company is capitalized at $300,000.

The Reddinger Carving Works, Evansville, Ind., will erect a new plant, which, it is said, will be the largest in the United States devoted exclusively to carving in woodwork.

The Western Brick Machine Company, La Crosse, Wis., organized with $10,000 capital by E. F. Wege, and others, will commence the manufacture of the Wege brick-making machine.

The General Electric Company has authorized an expenditure of $1,000,000 for enlarging and improving the Fort Wayne (Ind.) Electric Works, one of its subsidiary concerns.

The plant of the Chicago Rawhide Manufacturing Company, 348 West Ohio street, Chicago, Ill., was destroyed by fire on the night of January 13, with an estimated loss of $150,000.

Plans are being drawn by David Pepper, Commonwealth building, Philadelphia, Penn., for an electric lighting plant at Meadowbrook, Penn., for the Seybert Institute for poor children.

Large German screw factory wants to install latest machinery for making screws, bolts and nuts of all kinds. Address prices and particulars to Machinist, P. O. Box 822, New York City.

The Etching Company of America, Chicago, Ill., will establish a plant in Kansas City, Mo., for the manufacture of etched brass signs, name plates, etc. Has opened office in the Commerce building.

The Superior Motor Vehicle Company, Buffalo, N. Y., organized for the purpose of manufacturing automobile trucks and vehicles, has made arrangements for the erection of a plant. J. Willard Lansing, 150 Michigan street, president.

Engineers Ballinger & Perrot, 1211 Arch street, Philadelphia, Penn., are receiving bids on additional buildings at the wall-paper plant of the Jacob Thomas Company, Newark, Del. These include mill building, color-mixing plant and boiler house.

The Construction Department of the National Electric Signaling Company, Brant Rock, Mass., would like to receive for filing purposes catalogs, circulars and price lists of shop and office equipment and of materials and supplies required in the manufacture of general electrical apparatus.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., February 7, for material to form the valve chambers in the main culverts of the canal locks, including structural material, castings, bolts, nuts, washers, etc., as per Circular No. 552.

T. B. Shertzer, 23 Flatbush avenue, Brooklyn, N. Y., has been authorized by the Lakewood Terrace Hotel and Sanitarium Company, Witherspoon building, Philadelphia, to prepare plans for an electric light and power plant, water supply and sewerage disposal plant at Lakewood, N. J.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: January 25—Differential and chain blocks, steel bolts (schedule 2141), triplex power pumps (schedule 2125), steel wheelbarrows (schedule 2138), radical drill, 20-inch engine lathe, 36- to 60-inch engine lathe, mortising machine, woodshaping machine, punch and tube formers, squaring shear, ring and circle shear, wood trimmer and saw (schedule 2127), sewing machines (schedule 2138), files, hand tools, pipe and bench vises (schedule 2132), aluminum, galvanized sheet steel, strip solder, ingot tin (schedule 2133), medium bar steel (schedule 2152), bar steel, mild steel plates (schedule 2140), machine steel (schedule 2131).

Business Items

Edwin Stillman has joined the sales department of Watson-Stillman Company, with territory in New York State. The southern railroad business of this concern is in charge of Frank C. Clark.

W. N. Best, 11 Broadway, New York City, is now manufacturing the oil and tar burner, regulating cocks, etc., formerly made by W. N. Best American Calorific Company, this lattern concern having retired from business.

Forthcoming Meetings

Joint meeting of the Boston sections of the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers, with the Boston Society of Civil Engineers, Hotel Somerset, Commonwealth avenue and Charlesgate East, Boston, on Friday, January 21.

American Foundrymen's Association and American Brass Founders Association; joint convention, June 7-8-9, Detroit, Mich.; headquarters, Hotel Pontchartrain. Richard Moldenke, secretary, Watchung, N. J.

National Gas and Gasolene Engine Trades Association. Semi-annual convention, Cincinnati, Ohio, June 13-16, 1910; headquarters, Hotel Sinton. Albert Stritmatter, secretary, Cincinnati, Ohio.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper catalog free. E.G. Smith, Columbia, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Machines designed; automatic special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

We design or build light and medium weight machinery, dies, tools, jigs, fixtures and model work. Matson Machine Co., Bethel, Vt.

Wanted—Small universal milling machine; $\frac{5}{8}$-inch screw machine; $\frac{1}{4}$-inch tapping machine. Parker White Metal and Machine Company, Erie, Penn.

Machinery to manufacture on contract; designers, patternmakers and founders; we can handle work from very light up to 15 tons. Hydrostatic Machinery Co., Rochester, N. Y.

Wanted—Purchaser for No. 2 Farwell milling machine, Grant hobbing machine and Gisholt tool grinder; all practically new and in A-1 condition. Box 755, AMER. MACHINIST.

Curtis & Driver, Buffalo, N. Y. Mechanical draftsmen; automatic and special machines, tools, jigs and fixtures of all kinds designed. Typewriters, adding machines and automobiles.

Wanted—Machine work for lathes, shapers, milling machines, screw machines, etc., and would be pleased to figure on your dies, jigs, models, sheet metal stampings and auto parts. The F. G. Marbach Co., Medina, Ohio.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

The construction department of National Electric Signaling Company, Brant Rock, Mass., would like to receive for filing purposes, catalogs, circulars and price lists of shop and office equipment and of materials and supplies required in the manufacture of general electrical apparatus.

Large German screw factory wants to install latest and best machinery for making screws, bolts and nuts of all kinds; first rate American makers of such machines will send keenest prices and catalogs with all particulars to "Machinist," P. O. Box 822, New York City. Direct correspondence preferred; agents not wanted.

THE ANNUAL MEETING of the stockholders of the Hill Publishing Company, for the election of directors for the ensuing year and for the transaction of such other business as may properly come before the meeting, will be held at the office of the company, in the Hallenbeck Building, 497-505 Pearl St., Borough of Manhattan, New York City, N. Y., on Tuesday, January 25, 1910, at 12 o'clock noon. Dated, New York City, December 6, 1909. Robert McKean, Secretary.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Young man, age 26, would like position as foreman for grinding department to take entire charge; A-1 mechanic, thoroughly competent; at present employed in the above capacity. Box 95, AMERICAN MACHINIST.

Tool room foreman and mechanical expert desires change; capable of handling large propositions, organizing and producing systematically tool work in all its branches, special appliances and devices for modern interchangeable manufacture. Box 61, AM. MA.

DELAWARE

Wanted—Position as draftsman; have a good experience as a mechanic. Box 68, AMERICAN MACHINIST.

ILLINOIS

Mechanical draftsman, four years' experience, desires change; at present checking in a department of twelve men. Box 88, AM. M.

Cost man and estimator; power transmission or other mechanical line; can install and operate accurate, practical cost and stock system. Box 112, AMERICAN MACHINIST.

Manager or superintendent of manufacturing plant; light duplicate machinery preferred; 25 years' practical experience; gilt edge reference. Box 83, AMER. MACHINIST.

Position as mechanical draftsman or assistant superintendent in or near Chicago; eight years' experience in shop and drawing room on jigs, fixtures, special and automatic machinery; references. Box 100, AM. MACH.

I want a position as superintendent or manager of factory; my specialty is electric power apparatus and Corliss or high speed engines; have a record of fifteen years' successful work; am both practical and technical; am worth and can earn $3500 per year; at present employed; can furnish references from present and previous employers. Box 89, AMERICAN MACHINIST.

INDIANA

Purchasing agent and office manager of ability and experience, desires connection with manufacturer; A-1 references; age 32. Address Box 110, AMERICAN MACHINIST.

High grade factory accountant open for engagement; good organizer and executive; experienced in stock keeping, shipping, etc.; good references. Address Box 111, AM. MA.

MASSACHUSETTS

Engineer and designer, 38; experienced on mill construction, power transmission, machinery, power, pumping plant, hydraulic elevator layouts and estimating. Box 75, AM. M.

An American, 40 years old, superintendent; 22 years as die and toolmaker, machine building, cost reducing and up-to-date methods of manufacturing interchangeable parts; a position similar; best of references. Box 98, AMERICAN MACHINIST.

Superintendent or assistant; age 38; wide experience handling large number of men; a first class organizer and executive, full of push and energy; practical machinist and toolmaker; highest references. Address Box 107, AMERICAN MACHINIST.

MACHINING METHODS on an ENGINE BED and PARTS

Some Large Operations Accomplished

BY S. R. STONE

The handling, setting and machining of large castings is always an interesting proposition and when special machines and fixtures are used in performing some of the operations it makes the work doubly interesting as many times the special apparatus can be applied to other kinds of machine-shop work effectively and economically.

In Fig. 1 is shown the one-piece casting, weighing 210,000 pounds that forms the bed, frame and slide of a huge blowing engine. It is just being placed in position on the planer, by means of two cranes. Here the straight upper edges of the main bearing are machined.

From there the casting is transported directly across the aisle and set upon the floor plate in front of a Morton portable draw shaper, as shown in Fig. 2. Owing to the enormous size of the piece, no attempt is made to line it up on the floor plate and there is no necessity for doing so, as the tool itself can be put in such alinement, and otherwise adjusted, to meet every purpose required. At this stage of the work the bearing, sides of the slide, bosses, or any other parts that need surfacing, are finished and the piece is then lifted by the cranes about ten feet farther down the floor plate.

In Fig. 3 are shown two views of the casting as it is blocked up on the floor plate so that it may be worked upon by the special boring bar shown at the head of the casting and described and illustrated on pages 698 and 699, Part 2 of Volume 32. The chief object sought is to make the upper and lower interior surfaces of the slide two absolutely identical, concentric arcs, and this is the only trustworthy method of accomplishing that end.

When this operation is finished the casting goes to the large rotary planer illustrated and described on page 979, Part 1, of Volume 31. There the exterior side surfaces of the main bearing, as well as of the flange connection to the steam cylinder, are machined. Unless there is something special in the design which requires further operations, the piece is then sent directly to the erecting shop. Any small boring or milling of parts difficult of access has already been performed by the portable draw shaper which has special attachments for that purpose.

Meanwhile the steam and air cylinders

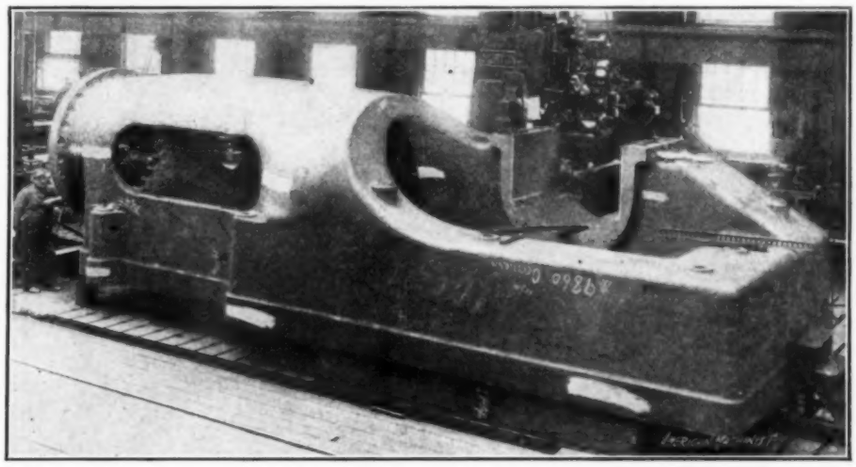


FIG. 2. LOCATED ON FLOOR PLATE FOR MACHINING THE BEARING WITH A DRAW SHAPER

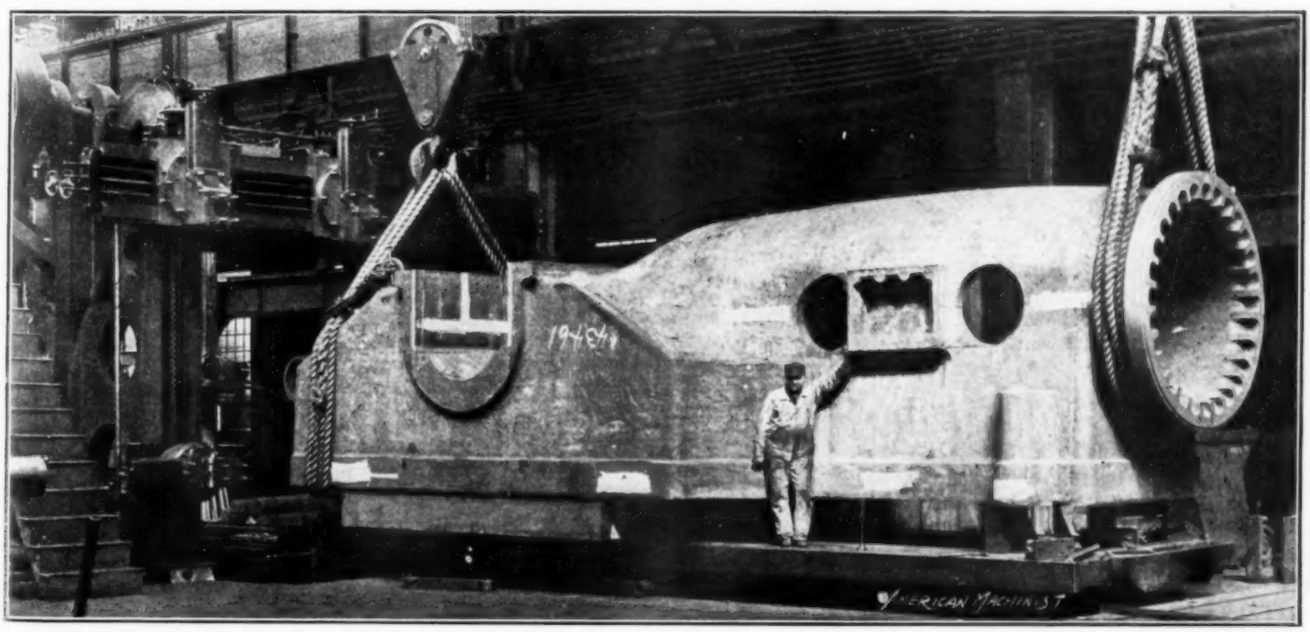


FIG. 1. ENGINE-BED CASTING WEIGHING 210,000 POUNDS, BEING PLACED IN POSITION ON PLANER

have been carried through a similar set of operations, a feature of which is the boring and finishing of the valve ports by the special twin machine shown in Fig. 4. This works upon two parts at a time and when they are finished the cylinder is quickly reversed by the crane so as to give access to the other two.

Simultaneously, the crank-shaft forging is being machined upon the special tool shown in Fig. 5 and the rods, pistons and other similar parts are also being worked out. The illustration of the huge lathe is reproduced from a photograph taken by the builders just prior to shipment, the location of other tools about this machine as it stands in the shop, making it impracticable to there obtain a view that adequately shows its construction.

This lathe is really a most interesting machine, because of the unusual provisions made to handle large work with practically the same ease and despatch

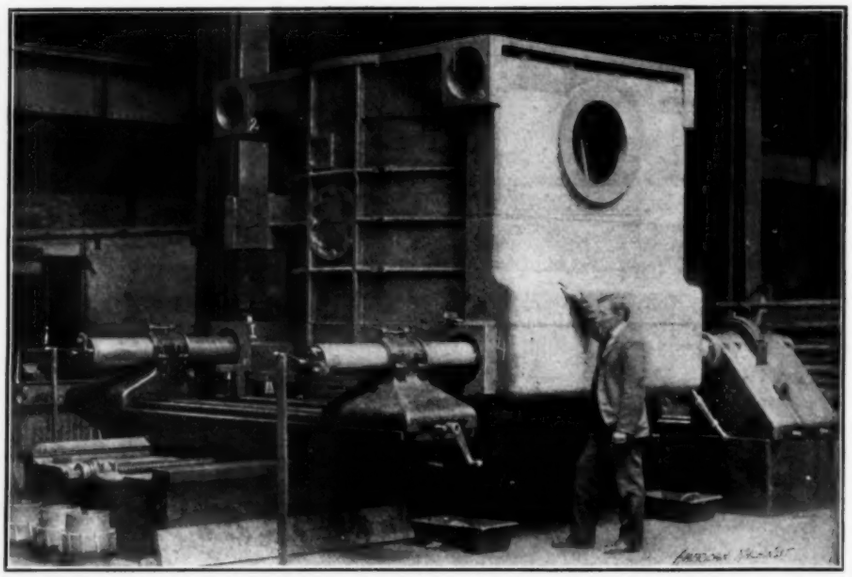
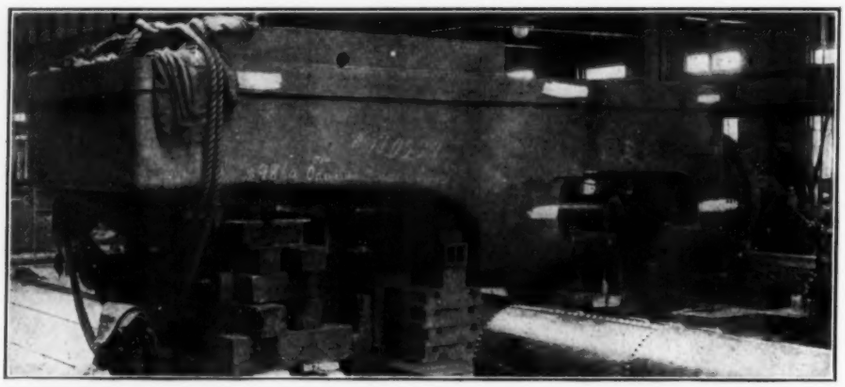


FIG. 4. SPECIAL TWIN MACHINE FOR BORING AND FINISHING VALVE PARTS



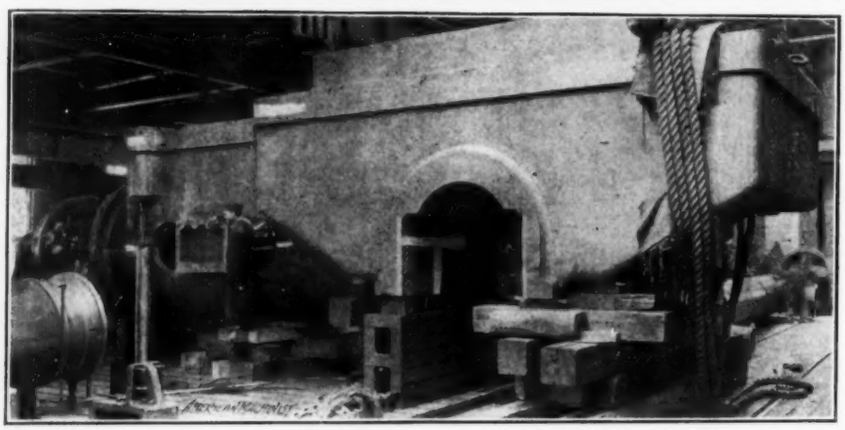


FIG. 3. BOTH SIDES OF CASTING AS BLOCKED UP ON FLOOR PLATE

that characterizes the performance of the ordinary small standard tool designed for much lighter work. It was built as a special 96-inch crank-shaft lathe, screw cutting, with five shear bed 42 feet 6 inches long in two sections for 30-inch centers. It is driven by a 24-horsepower motor with a speed range from 280 to 1115 revolutions per minute. There is fast traverse of the carriage at 30 inches per minute through two 7½-horsepower motors, as shown at the left. The tail-stock traverse is at 4 feet per minute through a fourth 7½-horsepower motor. All motors are direct geared.

In Fig. 6 are shown two views of a special rigging that is attached to a Niles Tool Works boring mill for turning the globular shape on the outside of the main bearing castings. The two castings are fastened to the platen of the boring mill and as this is revolved the arm holding the cutting tool is made to travel on the circle segment, shown under one foot of the ladder in the right-hand illustration, as this tool is being fed upward by the rod attached to an arm on one of the spindles of the mill. The tool arm can be moved in and out to adjust it for turning any size of globe desired.

The accompanying views do not all show parts intended for the same engine, as they were taken at different times; but the piece is in each case near enough to serve as an illustration of continuous work. Such operations as are described need not necessarily be taken in the same order or performed, in each instance, by the same machines.

A notable feature of the shop in which this work is done is the absolute elimination of shafting, except in the galleries, where a large number of very light tools

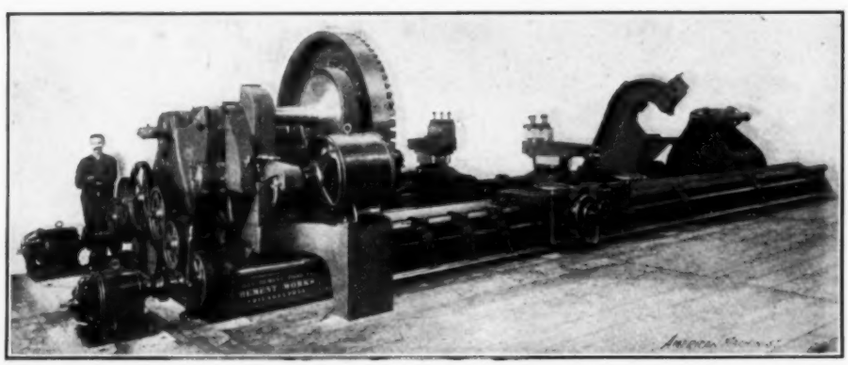


FIG. 5. SPECIAL 96-INCH BEMENT LATHE FOR TURNING THE CRANK SHAFT

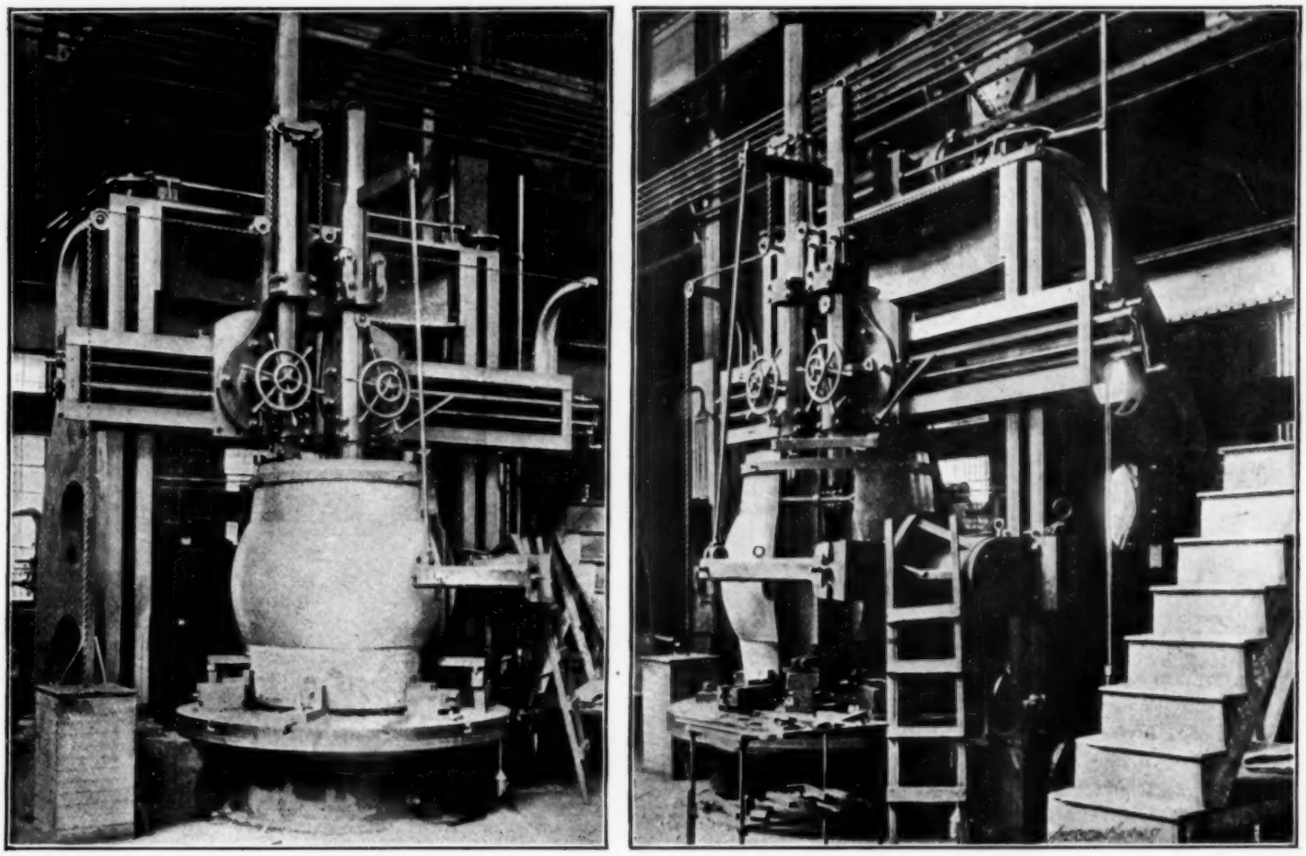


FIG. 6. SPECIAL ATTACHMENT ON NILES BORING MILL FOR TURNING LARGE GLOBULAR ENGINE BEARINGS

are at work. All of the power needed is applied by means of electric motors and pneumatic devices of various kinds supplied through wires and pipes from a central power plant, during the day. At night electric current is still available; but for overtime work, where compressed air is needed, the portable equipments shown in Fig. 7 are used. The one to the right consists of a Christensen compressor such as is generally used for air brake service. It is mounted on an ordinary truck and is driven by an electric motor, the base of which forms the top of the compressor.

Connection to the motor can be plugged in at any of a large number of points throughout the shop where sockets have been placed for the purpose. The general features of a similar system operated in connection with a heavy counterbalance, with its automatic control, were sufficiently covered in an article, on page 773, Part 2, of Volume 32, but the portable arrangement is comparatively new and bids fair to come into common use.

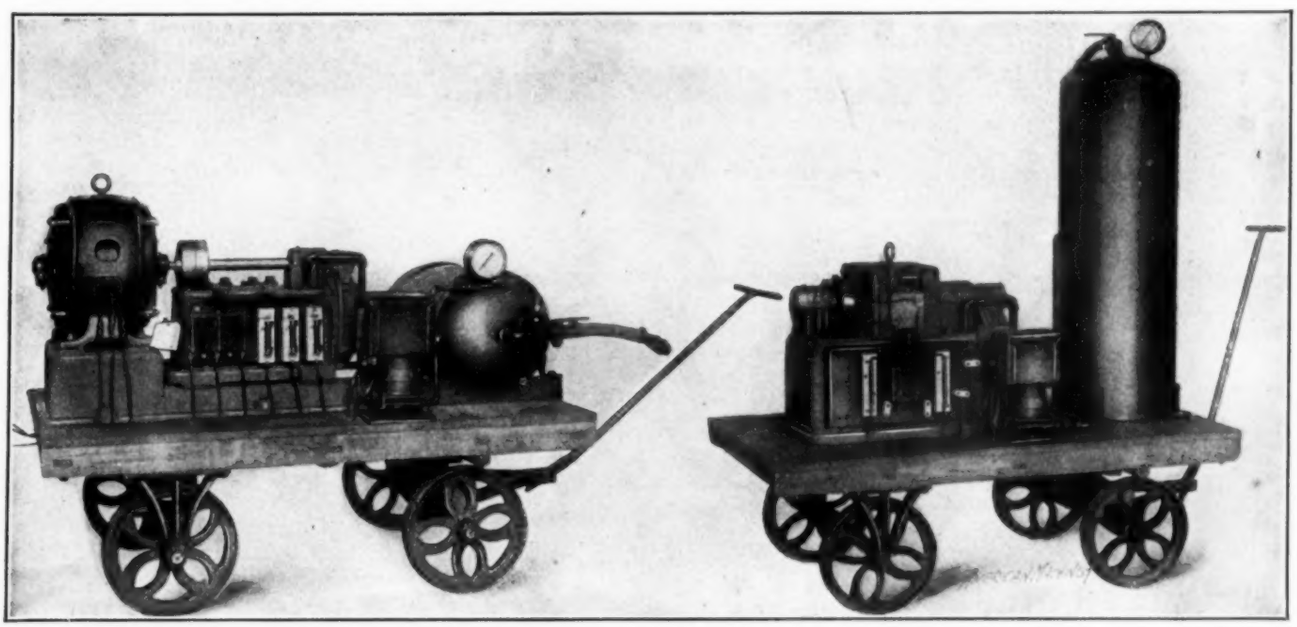


FIG. 7. TWO PORTABLE COMPRESSED-AIR OUTFITS, MOTOR DRIVEN BY CURRENT TAPPED FROM ELECTRIC CIRCUIT

Straightening Hardened Steel Spindles *By E. M. King*

Some years ago I had an experience in straightening a lot of hardened tool-steel spindles which I am going to relate, believing it will interest some of your readers and perhaps induce a few of them to give us the benefit of their experiences. I should have described this at the time but postponed doing so in the hope of being able, at some future time, to experiment more thoroughly in this line. While I have not had as much opportunity as I could desire to do this, that which I have had tends to confirm the opinions I then formed.

The Work and How It Was Hardened

The spindles of which I write were about 6 inches long, 0.7 inch in diameter for a length of 1 inch, 0.35 inch in diameter for the remaining 5 inches, and had a spline 0.1 inch wide and about 0.07 inch deep running the full length of the smaller diameter. There were about 20 in the lot and they were to be hard all over. They were made of Jessop's annealed tool steel, and hardened by being heated packed with charcoal in a cast-iron box, dipped one at a time, first in water and then in oil (as recommended by the makers) and at once reheated to a temperature of about 400 degrees, or until soft solder would melt when rubbed on the surface. They were all perfectly hard but about as straight as rainbows. Now as the spline which was not to be ground had to slide on a rather long key, it was necessary that the spindles should be tolerably straight before being ground to size. On testing I found them to average about 0.1 inch curved, so I was inclined to throw them in the scrap box and make new spindles having two splines diametrically opposite each other as I believed the change in hardening was due to the spline, particularly as they were all bent in about the same relation to the spline.

First Attempt at Straightening

The foreman, however, told me to straighten them and I did so by what I believe is the customary method; at least it is exactly that which I have seen used in some of the foremost shops in this country and the one which is given by E. R. Markham in his book "The American Steel Worker," from which I quote, from page 115, Fig. 46, as follows:

"The pliability of steel when warmed is illustrated in the case of such tools as taps, reamers or drills which become crooked when hardening. In order to straighten it is necessary to apply a certain amount of heat. Place the tool between the centers of a lathe with the curved side toward the operator; a piece of stock is then placed in the tool post of the lathe having one end against the bowed side, as shown in Fig. 46. The article is heated until oil placed on the surface commences to smoke; pressure is applied by means of the cross-feed screw until the article is slightly bowing in the opposite direction. *The piece should now be suddenly cooled while in this position.* If it is not straight the process should be repeated."

I followed this method except in the using of oil for gaging the temperature. Instead, I polished or rather cleaned the spindles with emery cloth and heated them with a bunsen burner until soft solder melted when applied to the surface. The lathe on which the straightening was done had a graduated collar on the cross-feed screw, so I could gage, comparatively the pressure I applied. I had a bench lathe and sensitive test indicator near by where I gave them the final test, so I had no particular difficulty in getting them fairly straight, say to within 0.002 inch.

Grinding and Reheating

I next rough ground them, leaving them from 0.002 to 0.003 inch over size, and was preparing to finish grind them when the foreman asked me if I had heated them up after rough grinding. I replied I had not, and was told it ought always to be done. Well, I heated them up as before until they melted solder, and let them cool slowly. Can you imagine my surprise when I saw that they were almost as crooked as before I straightened them, and with only about 0.002 inch to be ground off! I picked out the largest one 0.003 inch over size and about 0.05 inch bowed near the center, restraightened it, put it in the grinding machine and ground it true again. It was now 0.0015 inch over size; again I heated it as before and found it about 0.02 inch crooked when cold. In the first case of reheating the spindles after rough grinding I believed the reason of their changing their shape was due to the strains in the steel brought into action by the removal of the skin, as I had allowed 0.012 inch for grinding. In the second case, I reasoned that the slight amount I then ground off in order to true up the spindle could not possibly cause it to bend to such an extent, so I again straightened it but before grinding it I heated it as before and allowed it to cool slowly, free from any pressure. It was no longer straight.

Another Straightening Operation

I next straightened it without using water to cool it, but let it cool off slowly while still under pressure. It took much more time to straighten it than when using water, but I felt I was learning something, so when I got it straight I again heated it and let it cool without pressure and again it had become crooked but not very much so. Here was a little encouragement, so the next time in straightening the spindle I put on a little more pressure than necessary to straighten it so that when I took it from under pressure it was slightly bowed in the opposite direction. Upon again heating it and allowing it to cool slowly it assumed an almost straight position and did not change noticeably upon another heating. I now ground it true, removing no more stock than absolutely necessary to make it true and for the last time heated it. When cold I found it was still straight. The remaining spindles I restraightened *without using water.*

Treatment of Spindles with Two Splines

Soon afterward I had to make another lot of spindles, very slightly different from those described, to be used in the same machines. In these I milled two splines at opposite sides and was pleased to find they did not warp in hardening nearly as much as did the first lot. However, they all had to be straightened, but I used no water and always let them cool off slowly from the last heat without their being under any pressure. It was a slow job, but I felt well repaid for my trouble, for when I reheated them after rough grinding, only one showed the slightest change, and that change did not necessitate restraightening it.

Since that time I always heat up as hot as is allowable all straightened pieces before finish grinding them and find that in every case they change more or less, if in straightening they have been allowed to cool while under bending pressure and not subsequently heated.

In this work it often happens that when a spindle or other article is taken from the press and tested on centers it runs quite true, and there is quite a temptation to let it pass and in this way save time. However, I cannot help having a feeling that if a spindle is in such a condition that it will change very much upon the application of such a slight amount of heat as we have been speaking of, it is hardly safe to trust it to remain true and straight when subjected to the heating of the journals, strains, shocks and abuse, it is likely to receive when in use. I have seen sliding-spindle grinding attachments for bench lathes made by well known manufacturers, the spindles of which when used a short time become so crooked as to make them absolutely useless.

CAM GRINDING ATTACHMENT for the VERTICAL SURFACE GRINDER

EDITORIAL CORRESPONDENCE

Our readers are for the most part familiar with the vertical surface grinder built by the Pratt & Whitney Company, Hartford, Conn., and illustrated fully in these columns in 1907, at page 145, Part 2.

An important attachment, of ingenious design, for grinding cams, either detached or solid on their shaft, has recently been developed by the builders of this grinder and its principal features are clearly illustrated by the accompanying halftone and line engravings.

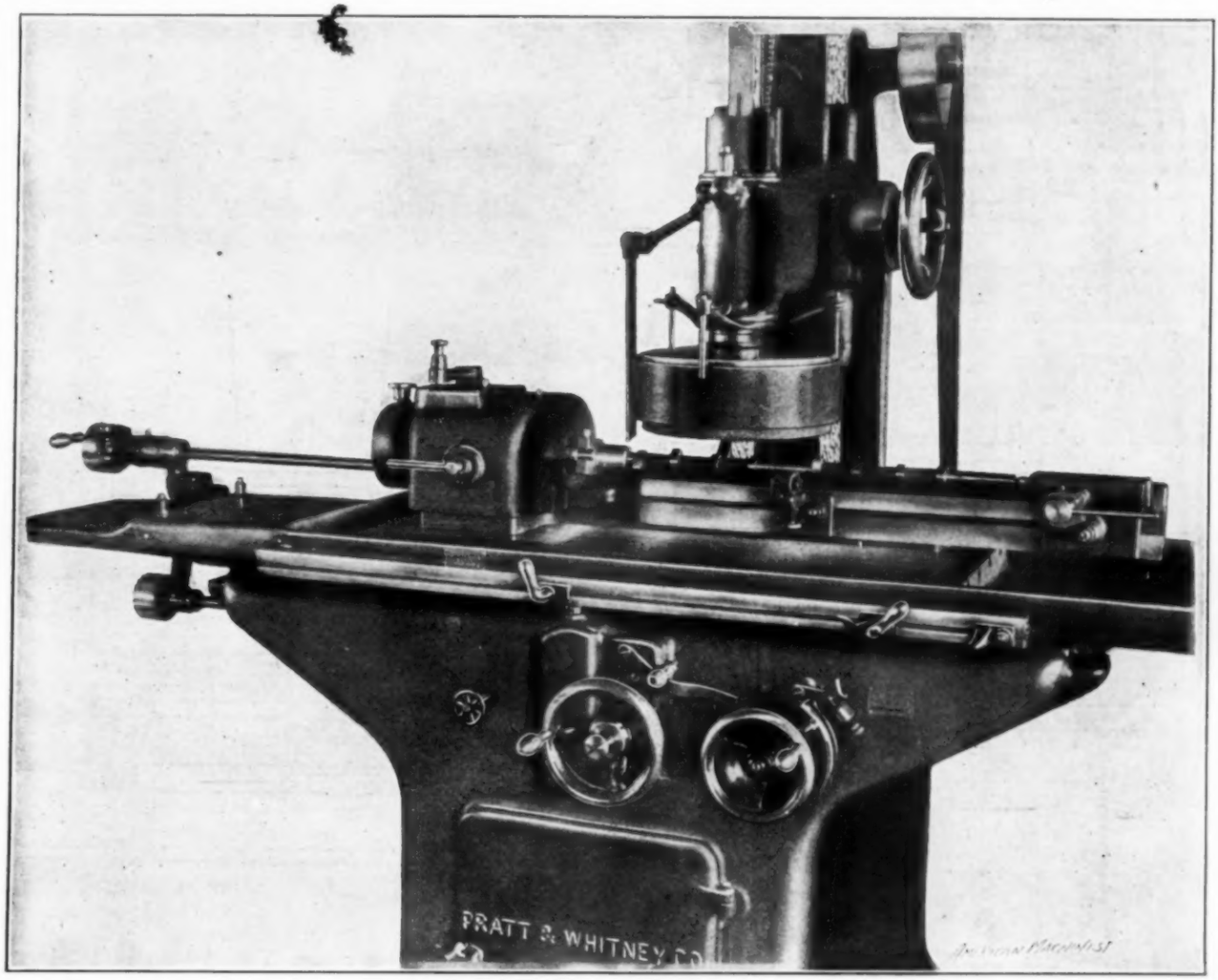


FIG. 1. CAM-GRINDING ATTACHMENT FOR PRATT & WHITNEY VERTICAL SURFACE GRINDER

PRINCIPLES OF OPERATION

The work produced on this cam-grinding attachment is finished with the cam surface in contact with the flat, lower face of the ring wheel so that any wear of the grinding wheel that may occur, in no way affects the shape of the cam; that is, the cutting face of the wheel revolves in a horizontal plane tangential to the path through which the periphery of the cam travels and it is obvious, therefore, that even though there should be appreciable wear of the wheel during the grinding of a series of cams this would merely render necessary a slight downward adjustment of the wheel head to bring the cutting face of the wheel into its original plane, without in any way causing a deviation from the original form of the cam as determined by the master cam in the head of the fixture.

This master cam when arranged as represented in Fig. 2, rotates in contact with a flat, hardened steel shoe, although in some cases the flat shoe is replaced by a hardened roll. In the former case where the flat guide is utilized, the master cam is, of course, an exact duplicate so far as its contour is concerned of the cam to be ground, thus making unnecessary any special layout to determine the form of the master. Where a contact roll is employed a slight modification in the shape of the master cam may be required

HOW THE WORK IS HELD

The machine as shown in Fig. 1, is set up for operating on an automobile cam shaft with eight cams forged in place on the shaft; four of them being inlet and four exhaust valve cams. The method of mounting the work between centers will be apparent upon inspection of this view and the drawing in Fig. 2. One end is secured in the driver by a key and the other carried on a spring-actuated tail

center which may be adjusted as required along the face of the fixture. Midway of the length of the shaft a universally adjustable steady rest is placed to take the downward pressure at the center due to the cutting action of the wheel.

The arm or rail upon which the tailstock is mounted is cast integrally with the head of the fixture and the whole member is mounted upon a longitudinal shaft at the rear and adapted to rise and fall, or oscillate in a vertical plane, about the center of its longitudinal bearings when acted upon by the master cam in the head. The axis about which it pivots is indicated at *A* Figs. 2 and 3.

The master cam bears when in action is located at *E* and as there shown it is fastened across a gap between two uprights cast on the base and between which the cam revolves and travels up and down with the movement of the head. The fixture head is made a close sliding fit on the guide surfaces of the base at *F F*, and as the head rises and falls with the work during the cam-grinding process it swings smoothly over the bearing surfaces *F*. The joint at this point, like various other bearing surfaces about the fixture, is closed with felt packing to prevent the passage of dust and fine abrasive to the interior of the head.

are two cylindrical steel plugs located vertically in the base and having a few teeth cut on one side which mesh with teeth on pinions *H H*. These pinions are long enough to mesh also with teeth in the long rod *I* which is located longitudinally in the base of the fixture and at the rear of the two vertical plugs so as not to interfere with their lower ends. A heavy, coiled, compression spring is placed on rack *I* between collar *J* and the right-hand end of the channel in which the rack operates, and this spring tends always to force *I* to the left, rotate pinions *H H* to the right, elevate the plugs *G G*, and so lift the fixture head and the work to the wheel. This vertical movement is, however, limited by the master cam *B*, Fig. 2, which in rotating against the con-

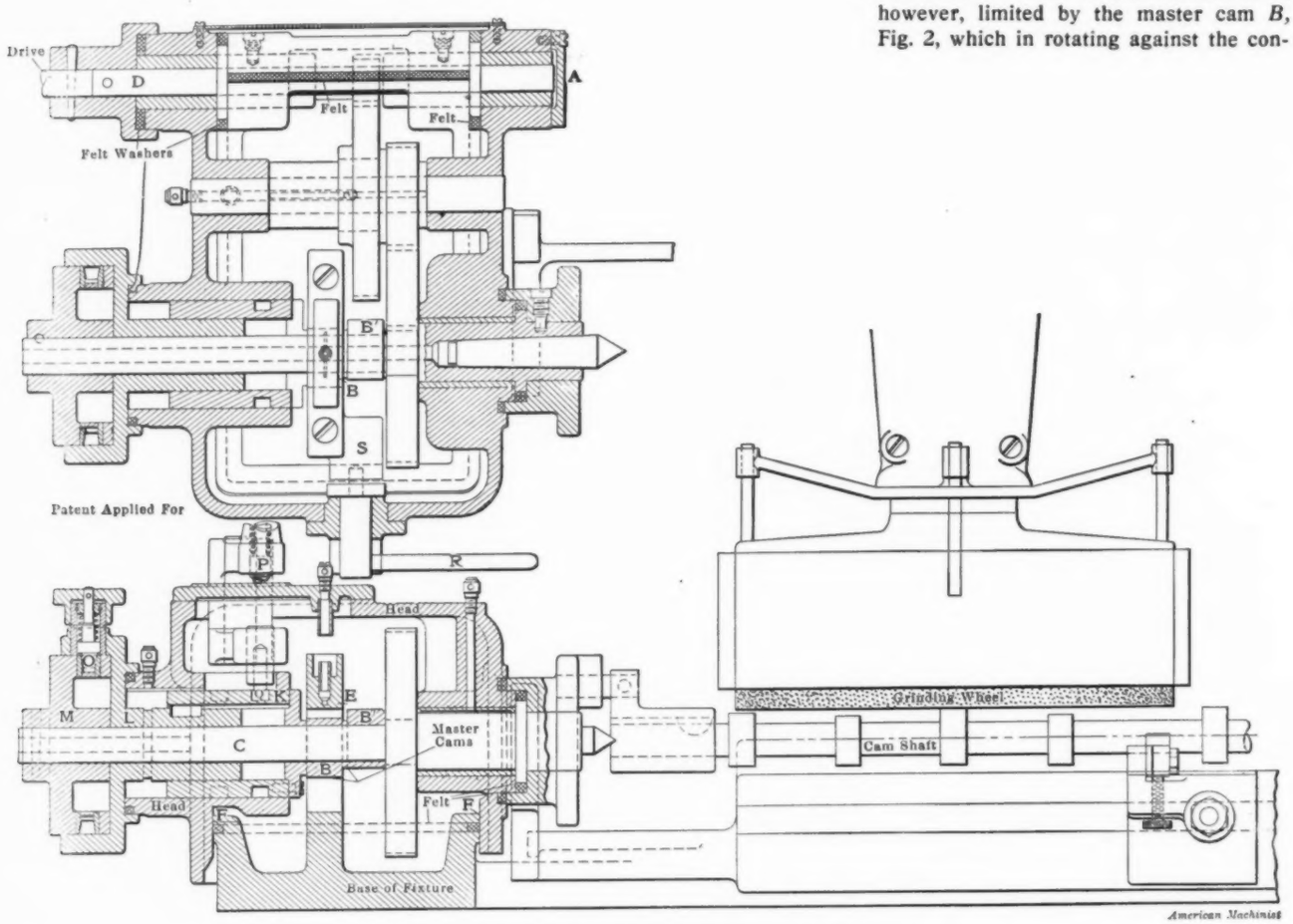


FIG. 2. CONSTRUCTION OF CAM-GRINDING ATTACHMENT

THE MASTER CAM AND THE DRIVE

The master cam is located as represented at *B B'*, Fig. 2, upon a shaft *C*, driven by means of a train of four spur gears from shaft *D* which is actuated from the same shaft as is employed for driving the rotary table when that member is used on the grinder. The shaft *C*, it should be noted, does not drive the master cam direct, the latter being a running fit upon the shaft, but instead, the shaft is connected to the cam through the medium of the indexing mechanism which will be referred to at another point in this article.

The hardened shoe against which the

The rail upon which the outer end of the work is supported extends a considerable distance from the head upon which it is cast, and to insure its rising and falling with the head without deflection at any point, thus maintaining parallelism throughout the length of the fixture at all times and positions, the simple but effective device illustrated in Fig. 3 is applied. This drawing, it will be noticed, shows merely the base of the fixture and the points of contact with the upper part or extension of the head.

SUPPORTING DEVICE FOR HEAD AND WORK

Near either end, at *G G*, Fig. 3, there

tact shoe *E* forces the head downward against the pressure of the spring-actuated lifting device, Fig. 3.

This device not only causes the work and carrying fixture to be forced upward toward the grinding wheel as far as permitted by the master cam, but it also serves as an equalizing medium by means of which the slightest vertical movement which may occur at either end of the fixture is instantly transferred to the opposite end; that is, any movement of either of the plugs *G* must instantly produce a similar movement upon the part of the other plug so that both ends of the movable portion of the fixture are acted

upon simultaneously and the work is thus always kept parallel with the table of the machine.

The Indexing Mechanism

By referring again to the sectional views presented in Fig. 2, it will be noted that all of the operating mechanism in the head, including the master cam, driving-gear train, work centers and indexing device, rise and fall with the oscillating movement of the head which is produced by the master cam in revolving against the stationary contact shoe, in conjunction with the equalizing lifting device illustrated in Fig. 3. The indexing arrangement is an important feature whose construction will be obvious upon inspection of the sections in Fig. 2. As there represented, and as already noted, master cam *B* is not attached directly to shaft *C* but is fastened to a sliding sleeve *K* which is feathered to the hub of the indexing member *L*. The latter is adapted to be rotated around index disk *M* which is pinned to shaft *C*, and by means of pin *O* and corresponding bushings in disk *M*, the two members *L* and *M* are locked together in the necessary positions for the grinding of the various cams on the shaft; the disk *M* thus acts as a driver for transmitting motion from driving shaft *C* back through *L* to master cam *B*.

In operation, with the machine set for grinding say, the series of inlet valve cams on the shaft, after the first cam has been finished, the grinding-machine table is adjusted longitudinally to bring the second inlet cam into position under the wheel, the indexing member *L* is unlocked from disk *M* and rotated to the next position, without turning the work and locked again, this movement adjusting the master cam around its shaft and locating it correctly for the grinding of the second cam. Similarly the other inlet cams are finished to correct form; their required angular relation to one another being preserved by the indexed positions of the master cam obtained through the rotary adjustment of shell *L* about index disk *M*.

Adjustment of the Master Cam

The master cam for the two sets of cams to be ground on the automobile cam shaft is represented in Fig. 2 as a double affair having two cams *B B'*, formed in one piece. After the series of inlet valve cams on the shaft have been ground, operations are started on the exhaust or outlet cams by simply sliding the master cam along on its shaft to bring the second portion of the cam (which in Fig. 2 is shown cleared from the contact shoe) into working position. This lateral adjustment which releases one cam and sets the other in operative position is obtained by means of a crank handle shown clearly at the top of the head in Fig. 1.

This crank carries a spring-controlled pull pin seen at *P*, Fig. 2, which locks it in two positions. The lower end of the crank-handle shaft has an arm carrying a pin *Q* which engages with a circumferential groove around the sleeve *K*, and when the crank is moved to right or left the sleeve with the master cam attached is moved accordingly; thus, when the handle is swung to the left, master cam *B* is slid out of engagement with the contact plate *E* and cam portion *B'* brought into engagement for the operations on the outlet cams. Here, as in the previous case, the different cams in the series on the shaft are ground in correct angular relation to each other by indexing the master cam by means of member *L*, pin *O* and driving disk *M*.

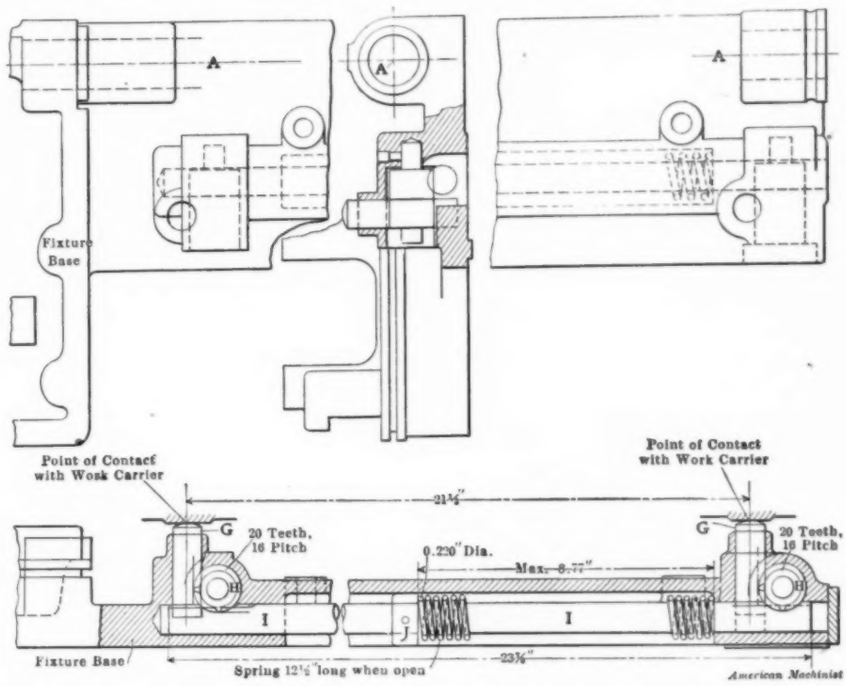


FIG. 3. BASE AND ELEVATING MECHANISM FOR CAM-GRINDING ATTACHMENT

Hand Control of the Fixture Head

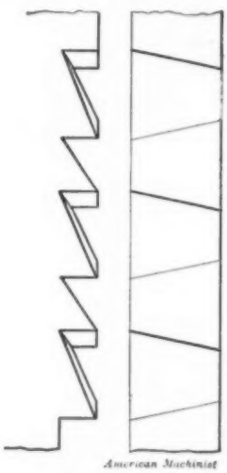
Before sliding the master cam on the shaft or indexing it around during the grinding of different cams, lever *R*, Fig. 2, may be operated to depress the head against the action of the elevating mechanism Fig. 3, and hold it down with the master cam entirely out of engagement with the contact shoe, thus enabling the cam adjustment to be easily and quickly made. The lever *R* is then swung back allowing the head to resume its former position with the master cam bearing against the under surface of the guide shoe.

The lever or pin *R* is clearly shown at the front of the head in Fig. 1. The stud to which it is attached has, as shown in Fig. 2, an eccentric portion of the inner end engaging in a horizontal slot in an extension of a lug *S* cast upright in the base of the fixture, and rotation of this eccentric stud must necessarily result in the movable head of the fixture being depressed or elevated according to the direction in which the operating handle is turned.

A Keyway Cutter

By Walter A. Perks

The line-cut shows a keyway cutter which we now use on our Baker Brothers' keyseater. Formerly we used a single-tooth cutter which would miss two or three strokes and then try to make up lost time by biting a chunk out. The cutter shown is very satisfactory, giving as it does, a shearing cut. The shear is alternately right and left so as to avoid side pull.



A KEYWAY CUTTER

Large Angle Valves for the Panama Canal

Considerable has been written about the Panama canal and the great locks that are being constructed for its operation. As these locks are so large, it must occur to some that the valves for the control of the entering and leaving water should be of interest, if only for their size. Reproduced herewith are some views of one of a set of 40 valves, now

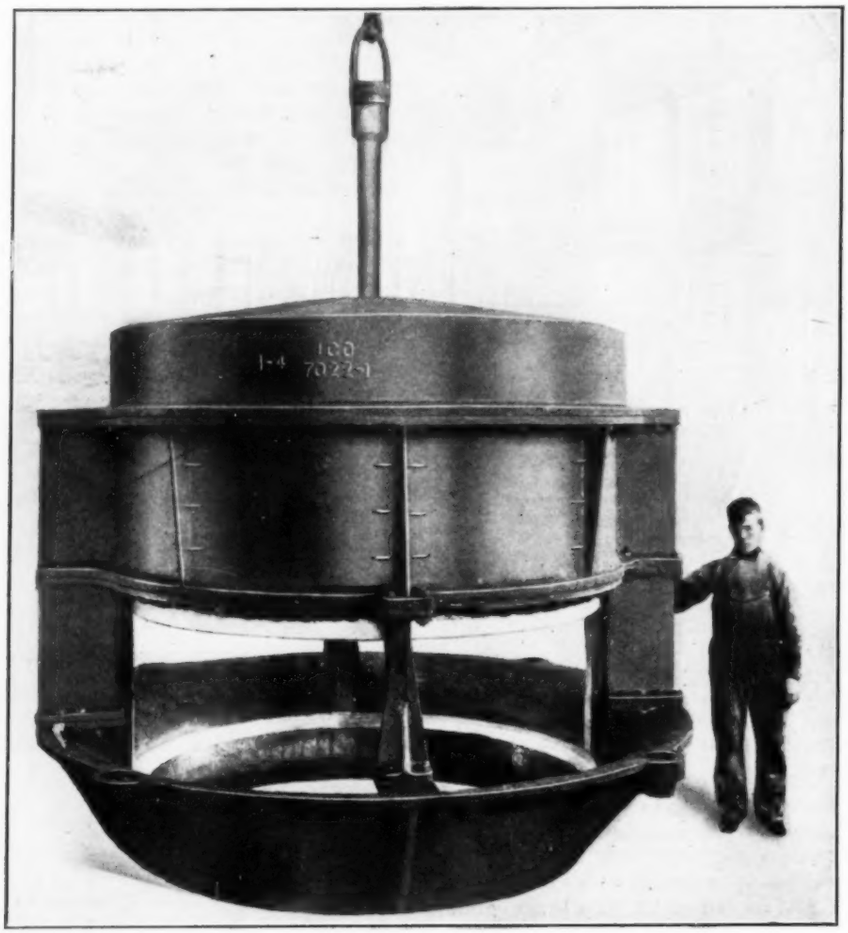


FIG. 1. LARGE WATER VALVE FOR PANAMA CANAL LOCKS
Upper white line is open gate. Lower white line is seat.

under construction at the plant of the Rosedale Foundry and Machine Company, at Pittsburg, Penn. As seen from the drawing, Fig. 2, the design is that of an angle valve. The water outlet at the bottom is 6 ft. 6 in. in diameter, and the diameter of the seat is just about 7 ft. Viewed from the standpoint of a gate valve, it must be admitted that they are of considerable size, while as angle valves, they are almost unprecedented.

As seen from the drawing, the seat section is of cast iron and is bedded into the concrete of the conduit. Resting in this seat is the annular valve ring, which is a steel casting with four radial webs connecting with a central boss, which receives the lifting spindle. This ring forms the closing gate. Above the gate section is what is known as the body section. This also is a steel casting and is bolted to the cover section, which is of cast iron. This cover section again is bedded into the concrete, being held by the four foundation bolts shown.

Between the body section and the seat section there are four pedestal guides, these also being steel castings and serving two purposes; first, to assist in the support of the body section, insuring alinement and maintenance of position and second, to act as guides to the ring gate. These guide webs fit into grooves milled in the side of the valve-gate ring, thus preventing the ring from turning around and effectively guiding it down to its seat.

Closing of the valve is accomplished by the steel ring upon the cast-iron seat, there being no removable seat section. It is not expected, of course, that the valves will be absolutely water tight, and this construction has been considered sufficient. At the top of the ring-gate section a joint is formed with the body section when the valve is closed, by leather washers extending entirely around the periphery of the valve. These leather washers are plainly shown in the large detail in the upper right-hand corner of the drawing, which shows a part section through one of the large pedestal guides. Water pressure on the outside will, of course, tend to press the lower leather washers tightly against the ring and the body casting, so as to prevent the water from flowing through the clearance between them. Above this and inside of the valve is another leather washer, which is attached to the ring itself. This inside washer would act to prevent any back flow of the water.

Curved cast-iron strips, held by suitable studs keep the leather washers in place, the strips themselves being located by screwed dowel pins. On the inside of the valve the upper leather washer is held down by cast-iron strips having lugs cast upon them which project into four grooves milled on the inside of the body casting. These are to assist in guiding the upper part of the valve when it is open.

It will further be noticed from the detail drawing that the stud bolts are deeply undercut below the threads. The necessity for this will be appreciated when it is considered that these valves, being bedded into the concrete and down in the bottom of long dark passages, a broken stud would be a disagreeable thing to remedy unless some means were provided for getting it out. By deeply grooving the studs as shown, it is assured that any break would take place at the groove, and there will still be a sufficient length of bolt projecting from the casting to grip with a Stilson wrench for easy removal.

As both the lower and upper sections of the valve casing are solidly bedded into the concrete, their removal is, of course, almost out of the question. However, in order to dismantle the valve when in place, the pedestal guide brackets are planed so as to form a tapered joint with the bottom of the body casting. Thus when the bolts are taken out of the guide pieces it is very easy to slide them out radially, then by the removal of the nuts from the studs holding the body to the cover, the body may be dropped down over the valve ring, and after lifting up the spindle the two may be taken out by way of the passage through the concrete. All these parts are doweled together to assist in reassembling.

It will be noticed that the opening of the valve is only between the body sec-

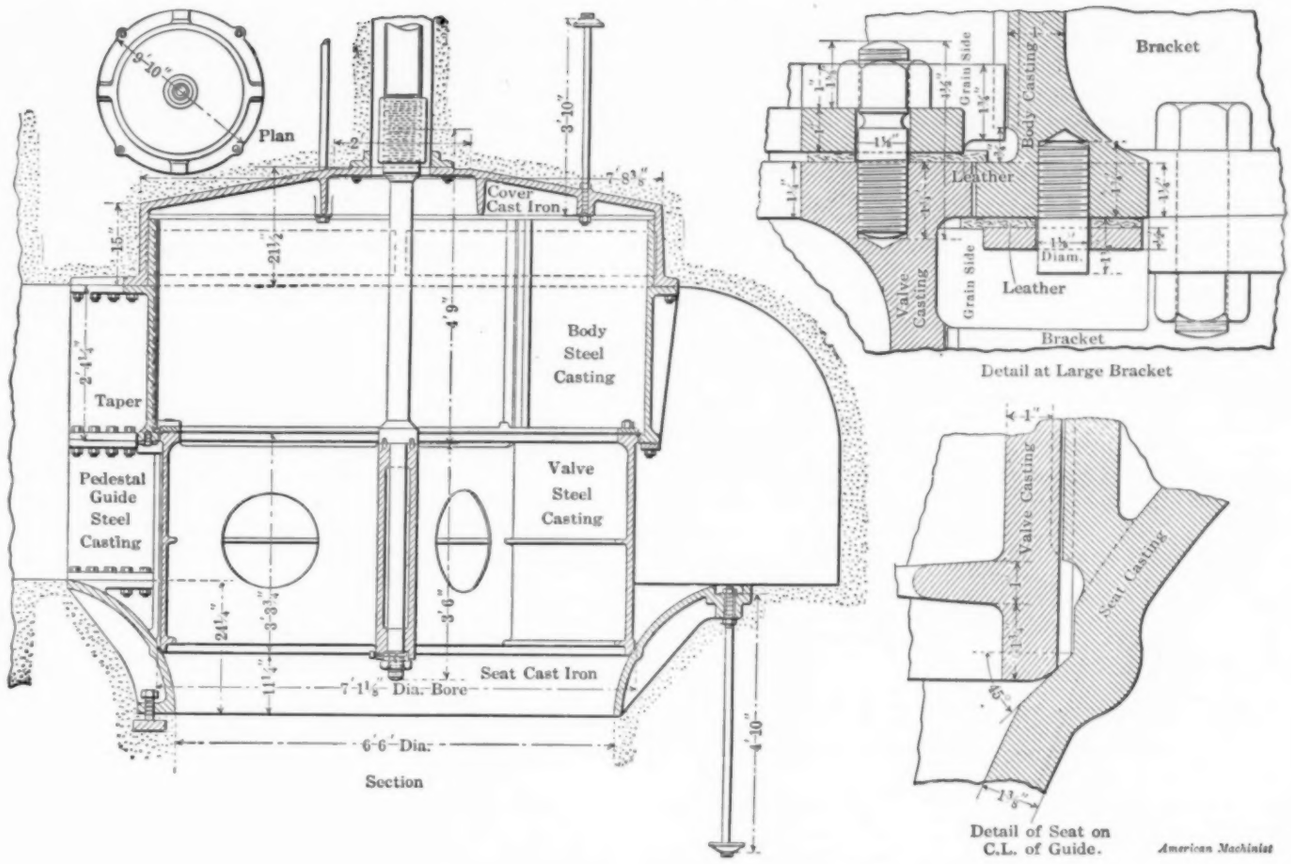


FIG. 2. CONSTRUCTION OF LARGE PANAMA CANAL VALVE

tion and the seat section, which at first appears to be only about half the hight of the water passage through the concrete. This is easily explained, however, when it is pointed out that the passage through the concrete extends entirely around the valve, so that the water entering from all sides, ample area is provided for the flow. Opening of the valve is, of course, accomplished by lifting the spindle, without twisting, and this is done by electric motors at the top of the shaft. Above the lower section, which is a steel forging, the spindle consists of extra heavy 6-inch galvanized pipe. It will be noticed that the valve is practically balanced, whether closed or open, so that no excessive load is brought upon the electric opening mechanism. Being balanced as to the water pressure, moreover, the weight alone should be enough to keep it closed.

At the lower right-hand corner of the drawing is a detail of the seat, this being a cross section through one of the brackets which support the pedestal guides. It is there seen that the brackets project into the milled slot in the valve, thus guiding it and preventing it from turning. The slots on the outside of the valve ring and on the inside of the body casting were cut by an end mill, and for the body casting, the ring itself was set right down over the milling machine.

It is said that in the making of these steel castings very great difficulty was encountered. As seen from the drawing, the sections are rather thin considering the large size of the castings, and after repeated trials it was found that the sections would crack upon cooling. In order to overcome this the well known device used by steel casters was employed; that is, to add thin webs or brackets in all the angles, in order to help hold the portions of the casting together. These webs were put in at every rib and bracket, and

FIG. 3. PANAMA CANAL VALVE CLOSED

also at the center of the valve ring where the radial sections meet the central boss. This construction assisted materially in obtaining castings without cracks, but, of course, necessitate the chipping off of the webs where they interfere with the design of the valve. Even when this was done, however, many castings were found to contain blow holes just below the surface, and from this cause had to be thrown out after being partly machined.

All bolts, studs and nuts are coated with zinc by the Sherardizing process to protect them from rust and to insure their easy removal when necessary.

Universal Chucking Device for Drill Press *By J. Van Deventer*

The drill press as used for cheap manufacture is equipped with proper tools, jigs and fixtures. In many cases each part to be machined will require an individual jig; on circular concentric work this is not necessary, and the sketches show a universal chucking device which serves for almost any work of this kind within its capacity.

The operation of the device is as follows: Swing bolt *H* is loosened and swung up, which allows arm *E* to be swung to one side. The article to be machined is inserted within the chuck jaws, and the chuck tightened, arm *E* swung into place and locked, the proper slip bushing inserted. The drill spindle and tool are then lowered, the latter through the slip bushing, the feed is thrown in and work begins.

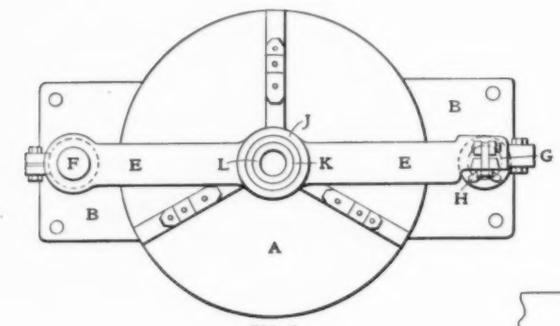


FIG. 1

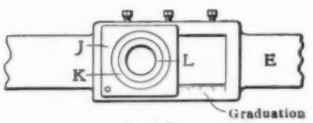


FIG. 3

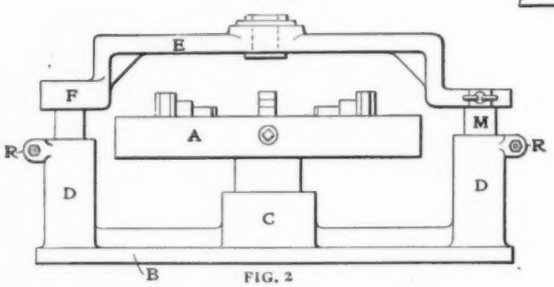


FIG. 2

UNIVERSAL CHUCKING DEVICE FOR DRILL PRESS

Figs. 1 and 2 show plan and elevation of the device, which consists of a universal chuck *A* mounted on a base *B* and preferably arranged for vertical adjustment by means of a column sliding within boss *C*. A swinging arm *E* is pivoted at *F* upon a column which has vertical adjustment within sleeve *D*. The other end of the swinging arm, *G*, is arranged to clamp against the end of a similar adjustable column *M*, being held by a swing bolt and nut *H*. When thus clamped the middle boss of arm *E*, containing a fixed bushing *K*, is located directly over the center of the universal chuck. Care must be taken to make the fixed bushing *K* of sufficient diameter to admit the largest tool which will be used in connection with the fixture. A complete set of slip bushings, reducing by sixteenths down to the smallest size drill required, completes the outfit.

The device may be mounted upon the table or base plate of the drill press, preferably the latter, and is doweled in position so that the fixed bushing and center of the chuck are in line with the drill spindle.

Among varieties of work which may profitably be done with this fixture are boring and reaming of pulleys; boring, reaming and facing of gears and pinions; drilling cast flywheels or handwheels which are to run true without turning; boring and tapping flanges, and countless similar round parts.

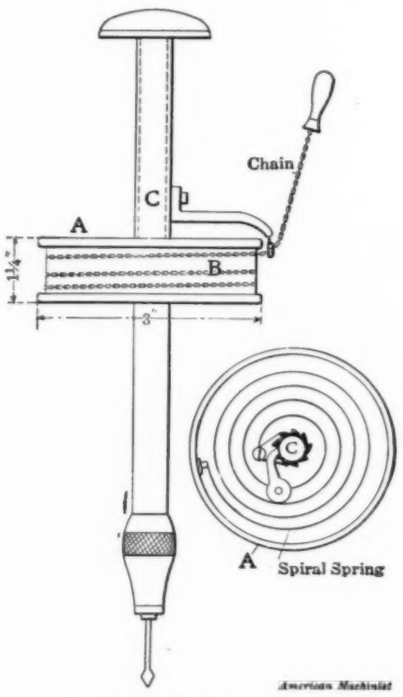
Fig. 3 illustrates a modification of the swinging arm showing an adjustable fixed bushing which may be thrown out of center when desired for the purpose of machining eccentric work. Dowel pins locate the central position and the required eccentric positions, or the slide may be graduated to show the eccentricity.

It may be thought that cast pulleys having little finish to turn from the diameter could not be bored and reamed in a drill sufficiently in line to run true; however, my experience has been that with this device the pulley will run as true as it would if chucked in a boring machine. In fact the limit of accuracy obtained depends entirely upon the original alinement of the fixture.

A Handy Small Brace

BY J. WALSHAM

It often happens that a small brace in very close quarters would be handy and I submit the one shown as being very useful for small work in unhandy places, where perhaps a hole has been forgotten. It is intended for light model work,



A HANDY SMALL BRACE

etc. It can be used in a small space and the chain pulled at many angles. The clutch *A* is rotated by the pulling of the steel chain *B* and returns to its former position by means of a spiral spring inside fastened to the shaft *C*.

BUILDING a NOVEL PROPELLER WHEEL PATTERN

Details in Constructing Blade, etc.

BY F. W. BARROWS

Large propeller wheels are usually made from a pattern for a single blade only, the two, three or four blades for the complete wheel being each made in a separate mold, and the separate molds assembled to form one, before pouring.

This fitting together of the part molds requires considerable skill on the part of the molder if good results are to be expected, and also experience in the use of spindle and sweeps necessary for this work. To the credit of the molder, it may be said that he is usually successful in this work, and has made many fine accurate castings of this kind.

But while comparatively large wheels can be readily produced from a single blade, by this method, it is plainly evident that as the wheels grow smaller, it becomes more and more difficult to make them in this way; the inaccuracy in spacing or in alining each separate mold, usually so slight in large wheels that it may be entirely disregarded, becomes a very serious and noticeable defect in small ones.

To avoid these faults and to save the cost of making separate molds for each blade, a cost which doesn't diminish in proportion with their size, small propellers are quite often made by using a wheel casting for a pattern. Such patterns may, of course, be accurate, but quite commonly are far from it. The casting produced, while it looks something like a propeller wheel, and will push a boat along—some—does not give the results which might be expected from a wheel of perfect pitch and spacing.

The pattern shop may be entirely competent to make a complete pattern in which these faults are entirely avoided, but the difficulties in the way must not be overlooked; and the errors once made are not easy to find and are hard to correct after finding.

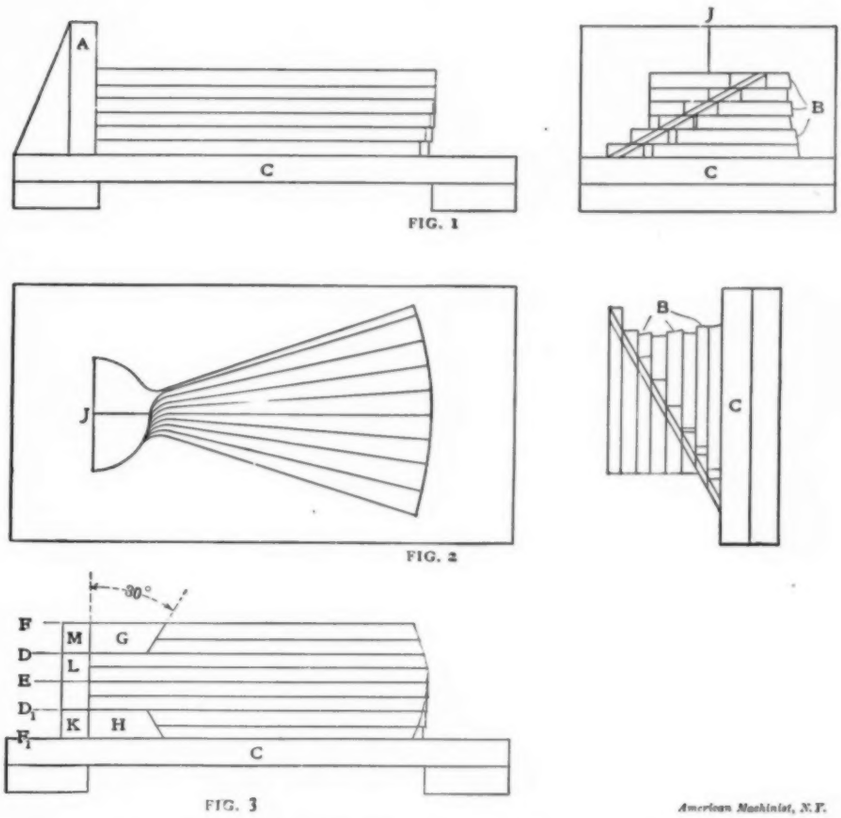
Difficulties to Overcome

When the irregular shape, not easy to lay out, is considered, and then its exact reproduction for each blade of the complete pattern, and having been laid out and successfully worked to the correct size and shape, there still remains the ever-present tendency of the material (wood) to spring, shrink, warp or swell; thus endangering that reputation for fine accuracy which "us patternmakers" sometimes possess.

But unless the reader is one of those who consider a propeller wheel simply as a crooked casting—sad to say, they frequently are crooked castings, and often are made by crooked methods—he will think this argument unnecessary, as he was already willing to admit what I am trying to establish: that large wheels, because they are made from a single-blade pattern, are, therefore, more accurate as regards pitch, spacing and balance than is the small wheel made from a complete pattern.

In designing a small wheel for experimental purposes, after the diameter, pitch and area had been decided upon, there remained the question as to the number of blades. As there was a pronounced difference of opinion on this point, it was proposed to make at least two patterns, two and three blades, respectively, and perhaps a third one having four blades; although it was pretty well agreed that the chances in favor of the four-bladed wheel were too slight to warrant the expense of the third pattern, more especially so, as this pattern would undoubtedly prove the most expensive of the three.

The question of pattern cost brought the patternmaker into the discussion, and he was able to suggest a method by which all of the three patterns might be made at a comparatively low cost. The method is applicable to almost any design and it is a money saver; especially when, as in the present case, several patterns, all of the same diameter and pitch, but having different numbers of blades, are wanted.



BUILDING UP CORE-BOX PATTERN FOR PROPELLER WHEEL

Method of Procedure

As the two-bladed wheel had the widest blades, this pattern was made first. One blade, with one-half of the hub, was built up in the ordinary manner; each course fitted against and secured to the joint board *A*, Fig. 1. The surface of *A* is a plane through the center of the hub and at right angles with the center line of the blade. A line *J* drawn on the surface of this board, fixed the center of the shaft and for each succeeding course. (This line is also shown in Fig. 2, across the hub.) Care was taken to have each course exactly parallel in thickness, and

its edge, beyond the fillet which joins the blade to the hub a true radial line. For reasons which appear later, the stock was glued up somewhat wider than the finished width of blade required; two extra courses being used each way from the center line.

As each course was sawed to shape, the strips cut from either side were used as blocking for the next course, as shown at *B*. After all courses were in place the upright board *A* was removed and the face of the blade, which is the top side in Fig. 1, was worked off to the lines, and the hub on this side of the blade finished.

Laying the first of the pieces *K* across the plate *C*, upon which the pattern is built, and with the dowels uppermost; put the second *L* in place and, having temporarily secured the two to board *C*, fasten *L* securely to the hub of the wheel pattern. Then place the third piece *M* in position and fasten it to block *G*. The bottom board *C* may now be removed, the hub cut off to line *D* and the blade cut away to receive block *H*, which is then fastened to *K*.

How the Cores Are Made

The core box shown in Fig. 4 is made with its depth equal to that of the glued-up stock, and the width and length such

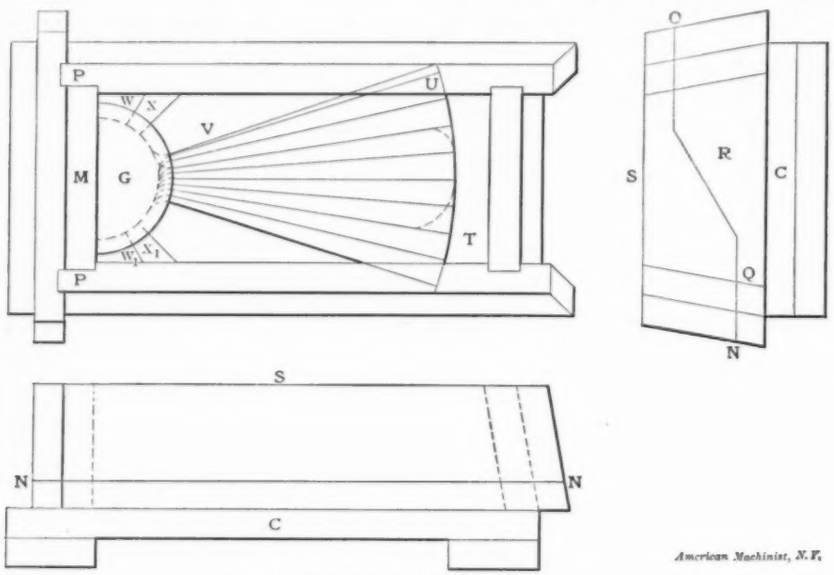


Fig. 4. Core Box and Core Making

to the end of the box by screws, and the board *C* again put in place to support both the pattern and box. After this pour liquid plaster on the finished side of the pattern until the box is filled to the top or narrow side *S*; then strike off the plaster true with the top *S* of box, and when it has set hard, remove it from the box.

This plaster is to be used as a match to support the pattern and form the parting when the first half of the core is rammed up. It is made on the face rather than back of the blade, as a match made on the back could be used for no other pattern, while if made on the face the pattern itself may be cut to any desired shape and the match still be used, the pitch being the one thing which must remain constant.

Now the blade pattern may be finished and when ready to use the cores are made as follows: With the pattern and plaster match closed into the box—the back corner of the blade pattern must be cut away at *U*, Fig. 4, to clear the box—all are laid on a bottom board, on the side of the box marked *S*. Fig. 4 shows the parts assembled for pouring the plaster match when making cores; the first bottom board being placed on the opposite side to that shown in the plan view. After this ram up the core on the back side of the blade; strike off the top; place a board (use *C*) on the top side *R* of the box; clamp bottom and top together and roll over. Then remove the board from *S* side, which is now the top; take off piece *G* with its bar *M*, and lift out the plaster match (the corner of

The pattern was now like Fig. 2; the face being finished, but the back still in the rough, with the outline of the blade still that of the stock, as glued up, and the hub, which was made straight to facilitate molding, the whole depth of this stock.

After this lay off the length of hub *D D*1, Fig. 3. Working from the center line *E* of the blade, get out two half circles *G* and *H*, the thickness to match the amount cut from each end of the hub, as *D F* and *D*1 *F*1. These half circles are turned, the smaller side to match the diameter of the hub and the edge at an angle of about 20 degrees with the center of the shaft line. The hub of the pattern is then cut away to line *D* and the blade cut to fit the half circle *G*; all as shown in Fig. 3.

Get out three pieces of stock; the width of one *K* equal to the thickness of the block *H*; the width of the second *L* equal to the length of hub, and the third *M* to match block *G*. The thickness of these pieces, all alike and parallel, should be proportioned to the size of the wheel pattern, and their length should be somewhat more than the width of the glued-up stock. The three are to be doweled together making one flat plate.

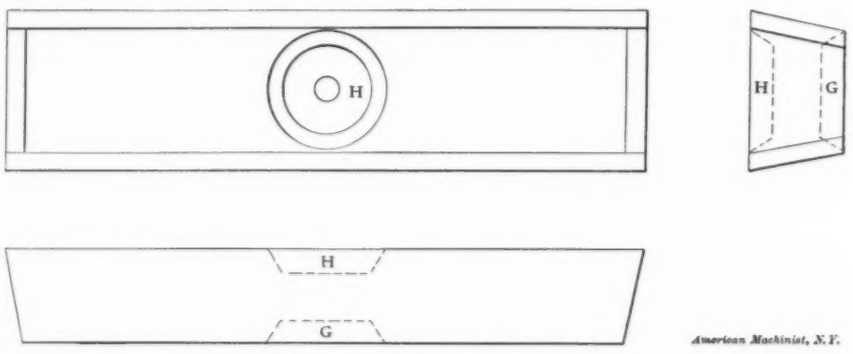


Fig. 5. Boxed-up Pattern for the Mold

as will allow not less than an inch of sand, outside of the finished pattern, at all points. The two long sides and outer end must have liberal draft; 2 inches to the foot is none too much. This box parts on what is approximately the pitch angle at the circumference of the wheel, as shown by line *N O* and *N N*. Three good dowels should be used in the point, and rabbets *P P* cut to receive pieces *K*, *L* and *M*, Fig. 3.

With the partly finished pattern held in the core box (placing the face side toward the narrow side *S*, Fig. 4) by pieces *K*, *L* and *M*; *L* may be fastened

the plaster at *Q* must be cut off to clear the box); replace *G* and close on side *S*. Put a little parting sand on the joint and finish ramming up the core. Irons for lifting the core are placed for side *R* at outer corner *T*, and for side *S*, at *V*; side *R* being the top of cone when set.

Draw out block *H*, Fig. 3; then lift off side *R* with its half of the core; draw out the blade pattern and blow out all loose sand; paste the joint and close *R* on again; clamp core plate on side *R* and roll over. The whole box may now be removed from the core and block *G* lifted away.

Operations on the Pattern

The pattern to be used for this two-bladed wheel is boxed up, as shown in Fig. 5. The width and thickness must match the core box, and the length must be the exact length of two cores. No clearance will be necessary for the setting of these cores, the extreme draft allowed in the box making it possible to have box and pattern both of the same size.

A recess *H* is cut into the top of this pattern to match block *H* in Figs. 3 and 5. There is a second recess opposite *H* in Fig. 5 to match *G* of Fig. 3. Core-prints for the shaft-hole core may be placed in these recesses.

For the three-bladed wheel the blade pattern was narrowed up a little and stopping-off pieces *W* and *W*1 were fitted into corners of the core box, as shown in Fig. 4; the one used on the face side of the blade was cut in two to suit the plaster match. The angle included by these pieces is 120 degrees with the blade pattern at its center.

A new, three-armed pattern was necessary for this wheel, each arm having the same cross-section as the inside of the core box, and care was taken to have the lengths of all three arms exact. When the four-bladed wheel is made, it is likely that the blade pattern will be still further reduced in width, and a new pattern and more stopping-off pieces, as at *X X*1, will be required. Patterns like Fig. 5 are not expensive, but they should be accurately made and spaced.

The core box with its plaster match piece, having been once made, is available for any wheel of the same pitch and size of hub; the diameter may be varied within the limits of the core box.

This method might be used to advantage in the production of iron patterns, as it is evident that any shape of blade, within the limits of the core box, may be used; the only fixed parts being the pitch and the hub dimensions, and even these can be changed by making one new blade pattern, with its match piece, while it may still be possible to use the core box, and if so, all patterns made to fit it.

Ball Bearing Center and Hardening Method

By W. D. Forbes

Hardly a proprietor of a machine shop has not had to settle the question of high-speed steel. I got through with it just as I did with the measles and whooping cough, but I shall not go through it again. Those who sell this quality of steel are most charming men and entertaining in their talk, but having absolutely settled on what make of high-speed steel to use, I shall continue to use it until my death and this may be hastened by the talk of some steel men.

Generally I enjoy meeting these gentlemen, but when through with their arguments my head is apt to buzz, and I cannot understand how it is that some firms of the highest reputation in the land are using "exclusively" the brand of steel sold by the gentleman in my presence.

With the use of this high-speed steel I have found, not so much in my own works as in those where much heavier work is undertaken, that the dead centers of the lathes are giving trouble on the roughing cuts. On light work, little or no trouble is encountered, but on very heavy cuts the ordinary lubricant that is permissible on the dead centers does not do the work, and they break off and burn and become a nuisance.

I was thinking of trying a live tail-stock center, by using a ball back of the center and ball bearings at the front end. I would only use this, however, for roughing, as undoubtedly there will be some lost motion which would be objectionable on a finished cut, and therefore would make the center in such a way that I could lock it firmly for the finishing cut.

I am not quite sure that centers with ball stops and bearings will work well. Has anybody tried this? If so, it would be interesting to readers to know what results were obtained.

In considering the high-speed steel question, I have talked with many friends, and one of them showed me a most interesting treatment of ordinary good cast steel. The apparatus consisted of a cast-iron pot holding about two gallons. It was set up and entirely insulated, and to it was connected the negative wire of a 250-volt direct current.

The pot was filled with the ordinary hardening solution of cyanide. Above it was a movable insulated bar the lower end of which was provided with means for clamping a tool, while to the upper end was connected the positive wire. This bar could be moved down until the tool was immersed in the solution in the pot; the current was then thrown on for a very short time, not more than two seconds; the switch thrown off and the tool was most beautifully hardened and stood up as well as any high-speed steel that I had tried. This current could be kept on until the tool actually melted at its point, but, of course, it could not be burned under the conditions. The current was heavy, but the time it was used was extremely short.

This process may be patented, but I do not think so. It could be used most advantageously in hardening reamers, as around the pot could be hung cast-iron strips that hang close to the cutting blades of the reamers, so that when the current is turned on the blades are nicely hardened and the rest of the reamer left soft. Taps could be treated the same way. I was told that cutters, where warping would make them useless, were treated with perfect success, no warping occurring.

Still this steel question is most important. I am looking for a decided advance in removing metals rapidly and successfully by the use of oxyhydrogen and acetylene torches or flames. I have seen successful work done by this apparatus, and they are becoming very simple to operate and are filling a field which will widen. The welding done by this torch is most satisfactory, and as its price is by no means high, it seems to me that it must become more common. I hope very soon to be in a position to make some most interesting trials with this class of torch in view of determining the strength of the welds, and the cost of removing metals, and the time taken to do this work, and as soon as I have gotten through with it I think it will interest your readers.

Two Motors and One Line Shaft

By O. S. Bickford, Jr.

When we found our little two-horse motor getting pretty nearly all the load it could carry we thought to divide the line shaft and drive a part with another motor, but the question arose at once as to where to make the division, and after a little hesitation at the novelty of the plan we decided to get a three-horse motor and hitch up side by side with the other.

These two motors have now been running eight or nine months and pull together as nicely as a pair of horses.

We used pulleys to give the same speed of main line from each motor, which runs at 1800 revolutions and now we can put full load at either end of the line and also have the advantage of using only one motor when we need a small amount of power.

These are operated by switches placed side by side and when we wish to use only one motor we close both switches together and pull one out, thus losing only what power is taken by the line shaft to drive the rotor of the other motor.

As our motors are small, no starting device is used, but we believe it would be practical to use larger motors coupled up in the same manner.

CHUCKING and FORMING on an ENGINE LATHE

Efficient Duplicate Work with the Aid of Special Tools

EDITORIAL CORRESPONDENCE

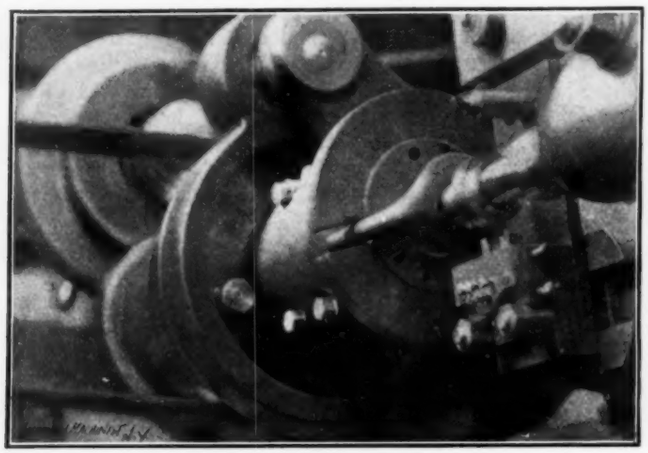


FIG. 1. FORMING THE SPINDLE-GEAR BLANKS

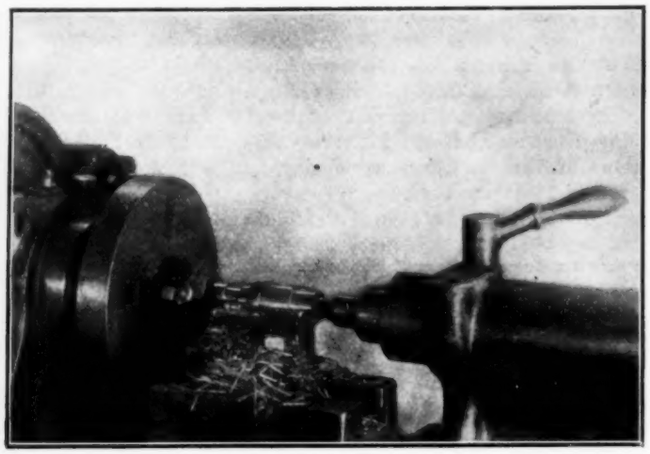


FIG. 2. FORMING THE FEED-ROD BUSHINGS

There are some interesting examples of using an engine lathe for chucking and forming work in the shops of the Seneca Falls Manufacturing Company, Seneca Falls, N. Y. Taking their own operations, we can begin with the forming of the spindle-gear blank, as illustrated in Fig. 1. The piece of steel has been previously bored and the keyway cut so as to be driven by a key set into the arbor for this purpose.

The arrangement of the tools can be clearly seen, and it will also be noted that there is an extension from the under part of the tool block carrying a post which holds the scoring tool, it not being convenient to combine this with the forming tools in front. This is for cutting an oil groove in the edge of the gear blank, and both this and the forming tools are controlled by stops which determine the size.

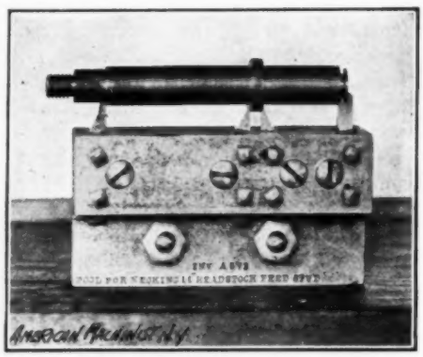


FIG. 3. TOOL FOR SIZING SHOULDERS OF FEED RODS

The method and the tools used in forming the stud bushings are shown in Fig. 2. The work has been previously drilled and the oil groove cut so as to serve as a keyway for the piece on the arbor. It is formed at one operation to within about 0.005 inch. The shoulders are finished with a sizing tool and the cylindrical surfaces are ground to size.

TOOL FOR SIZING SHOULDERS

The tool for sizing the shoulders of the feed stud for the headstock so as to have them all the correct length, is shown in Fig. 3, and indicates both the style of tools largely used and the way in which each tool is plainly marked so as to avoid mistakes. This tool also makes undercuts or scores so that in grinding the

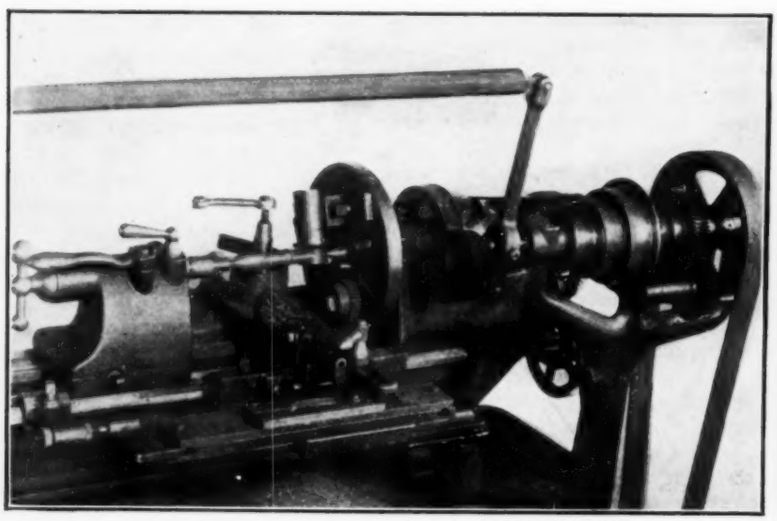


FIG. 4. FORMING HANDLES WITH TAPER ATTACHMENTS

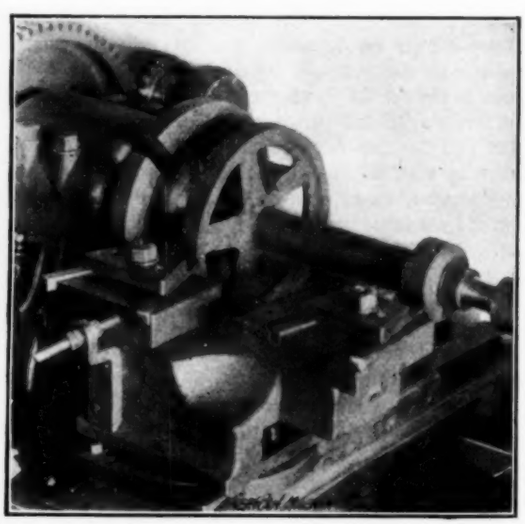


FIG. 5. FACING AND SIZING THE BACK GEARS

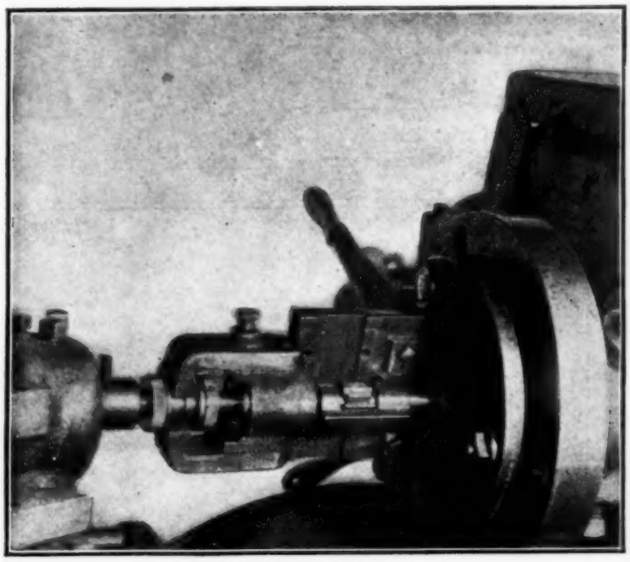


FIG. 6. BORING AND FACING WORM BRACKETS

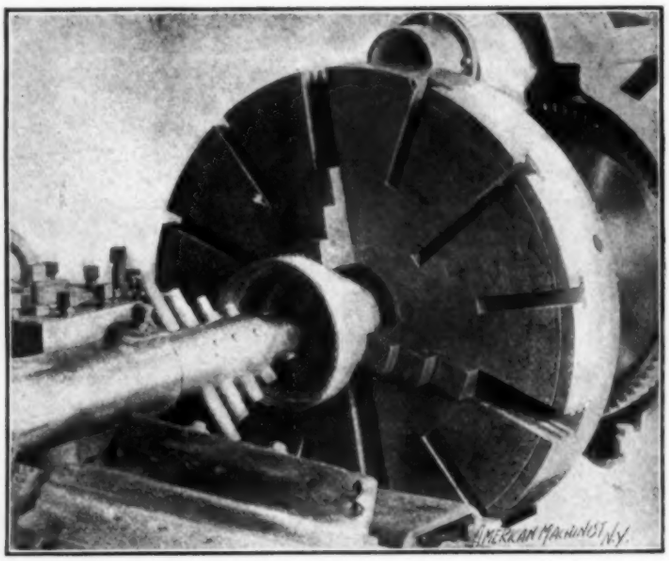


FIG. 7. BORING CONE PULLEYS

wheel may be run clear to the shoulders. As with the tools shown in Fig. 2, this is mounted in the tool block in place of the tool post, being photographed in the position shown to give the best idea of its construction.

Fig. 4 shows the way in which one of the 9-inch lathes uses its taper attachment for forming the back-gear lever handle. It is easily seen how the cross-slide is controlled by the form at the back. Incidentally, this also gives a method of motor driving which is somewhat unusual, the motor being located on the floor and belted up as indicated to the clutch countershaft behind the lathe.

In Fig. 5 a special tool block has been placed on the cross-slide in place of the compound rest and carries four tools. These tools turn and face both gears at the same time, the work being driven by the stud or angle iron projecting between the spokes of the larger wheel. As in

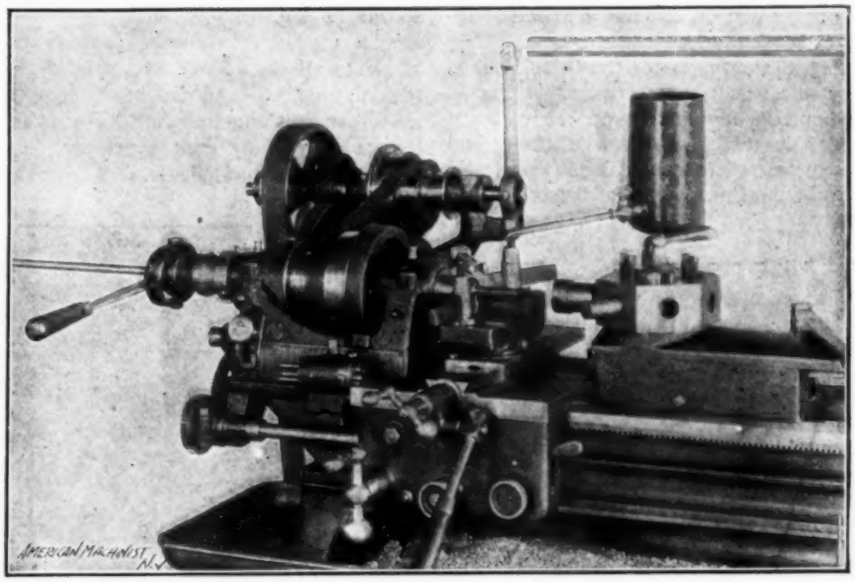


FIG. 8. LATHE FITTED FOR SCREW-MACHINE WORK

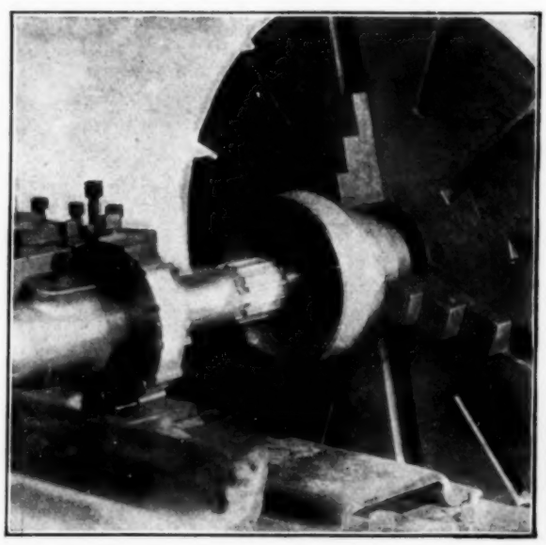


FIG. 9. REAMING CONE PULLEYS

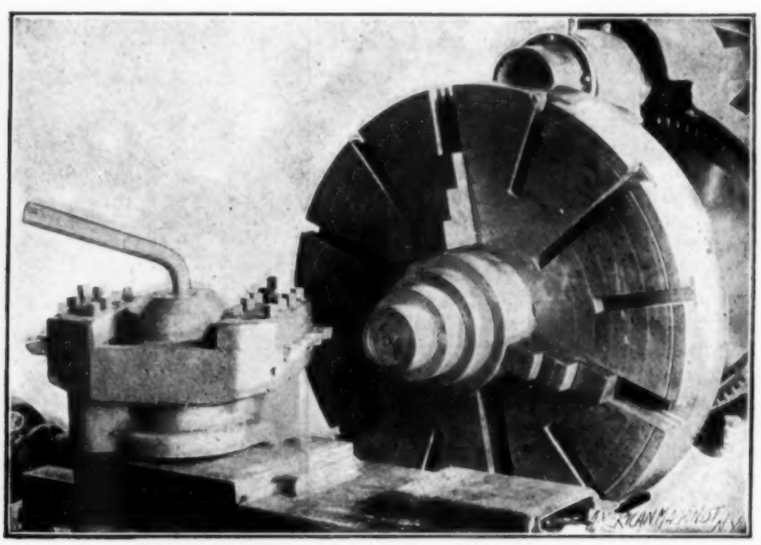


FIG. 10. TURNING AND FACING CONE PULLEYS

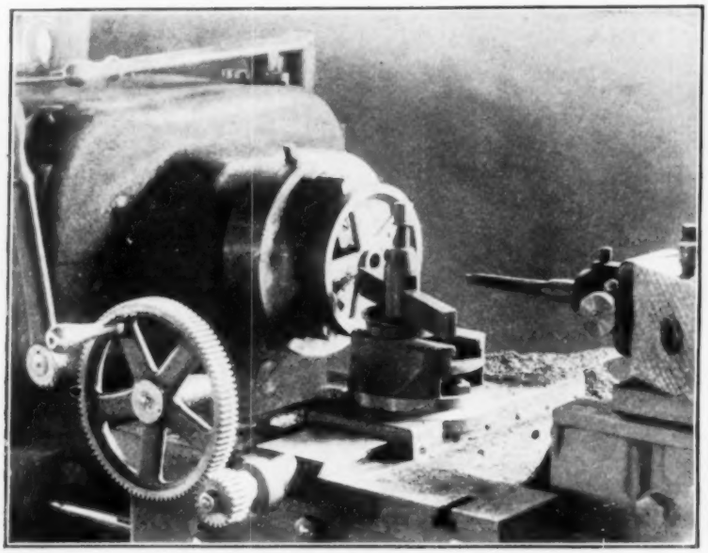


FIG. 11. SPEEDING UP CROSS-FEED SCREWS

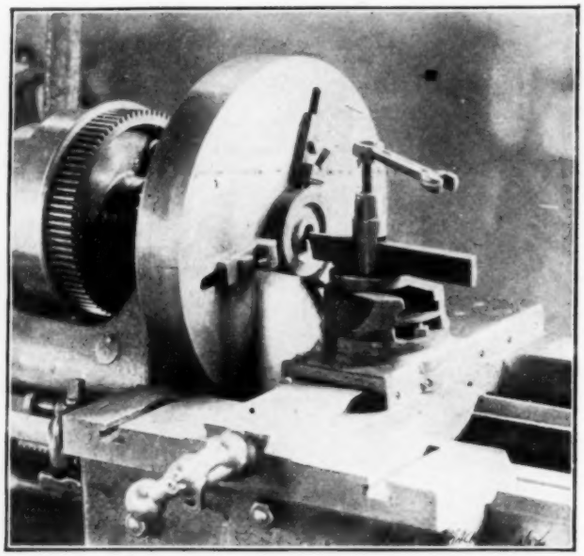


FIG. 12. CHUCKING FOR FACING SECOND SIZE

the other work, stops are provided to insure duplication of sizes.

Fig. 8 shows one of the 9-inch lathes with the same motor drive as in Fig. 4, equipped with a turret on the bed and a double tool slide, draw-in chuck and automatic rod feed, making it practically a screw machine for forming screws and studs.

A CONVENIENT FACING FIXTURE

The worm brackets for the carriage are bored and faced in the fixture shown in Fig. 6. This is mounted on the faceplate, the boring bar and reamer being guided by hardened bushings located on both sides of the work. The tool shown in place is used for facing the inside shoulder of the bracket for the worm. These shoulders are finished to correct size by means of the adjustable collars and stops shown on the end of the fixture. The cutter is secured to the arbor by a taper pin, the hinged arms acting as stops for the adjustable collars which are held in position by the nurled pins and are swung back out of the way when using the boring bar.

MACHINING THE CONES

Lathe-head cones are machined on a Gisholt lathe as indicated in Figs. 7, 9 and 10. The first shows the bar carrying five round tools which is used for the first boring. These also face the inside shoulders and the last tool turns and faces the outside end of the large cone so the grinding wheel may run to the shoulder formed by the flange which is attached to the cone before grinding. The cones are reamed, as shown in Fig. 9, in the same machine, the reaming being for the flange hub and the cone gear. Both the boring and reaming bars are guided on the inner end by hardened bushings in the lathe spindle in the usual way.

The third operation is the turning of the three smaller steps of the cone, as shown in Fig. 10, by the tools in the special toolholder shown. These tools also face all shoulders. One side of the special tool block carries roughing and the other finishing tools. Both ends of the cone are supported by a plug attached to the lathe spindle.

SPEEDING UP THE CROSS FEED

Fig. 11 shows a chucking machine which is used for boring and facing gear blanks. The unusual feature here is the speeding up the cross-feed screw for moving the tool quickly across the space between the hub and the rim. This does

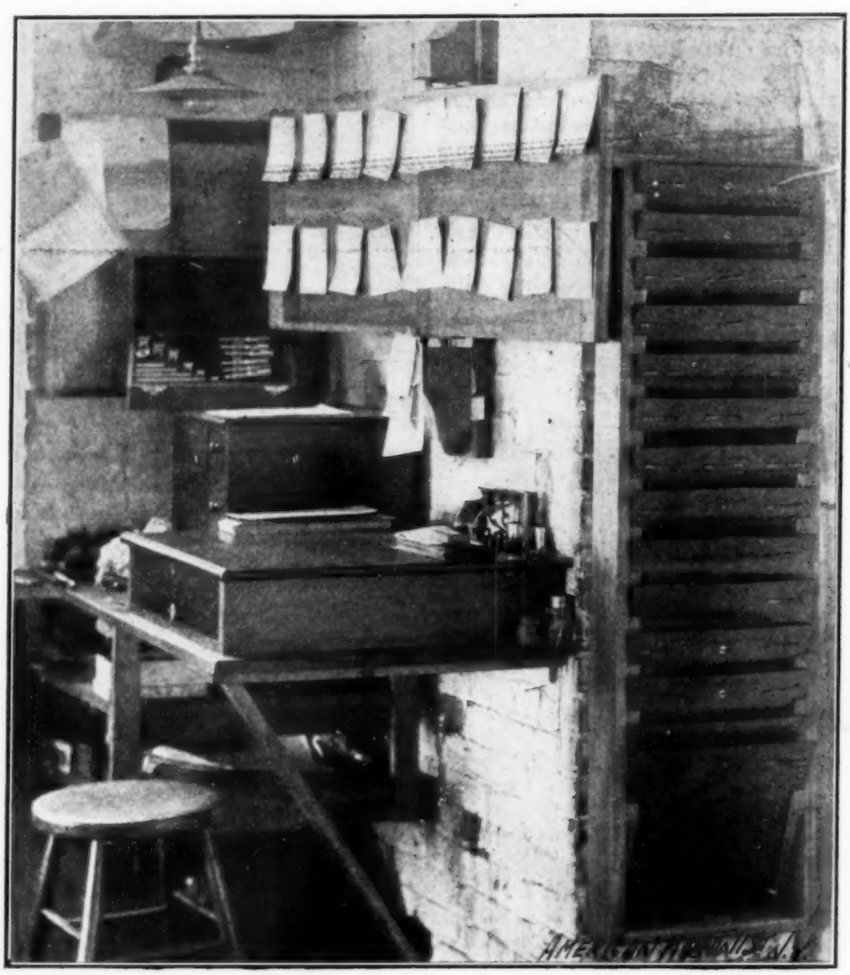


FIG. 13. FOREMAN'S DESK AND BLUEPRINT RACKS

not interfere with the power feed which is used when the tool is cutting. In use these gears are guarded in common with all other gears in the shop, but were removed for clearness of illustration. There is also a cross-feed boring tool used in the turret for truing up the holes in the hub.

Fig. 12 illustrates the manner of chucking gear blanks while facing off the second side. The position of the binding screws forces the finished side of the work against the face plate and insures parallel sides. Correct thickness is secured by a stop on the lathe bed in front of the carriage so that measuring is unnecessary.

Fig. 13 shows a very convenient cabinet or rack for holding blueprints for the foremen. The blueprints are all bound with pressboard covers in groups for different parts of the lathe, and each group has a place in this rack. The upper edge of each book bears the name of the group and is exposed so as to be clearly seen, enabling any book to be quickly selected. Above the foremen's desks are hinged boards on both sides of which are hung time cards, which also constitute the workman's order. When a man finishes a piece of work he takes the first order hanging on the pin bearing his number. This system enables the foremen to lay out each man's work in advance, keeping one or more jobs ahead as the case may be, and prevents delays and interruptions. This and many of the other interesting features of this shop are due to the superintendent, E. A. Oakes.

Semi-automatic Sheet Metal Trimming Lathe *By W. W. Patterson*

Most manufacturers of sheet-metal shells consider the trimming or edging operation a source of worry and expense when done on a small hand trimmer; several of the larger manufacturers have designed and built semi-automatic machines for this work, one of which, as shown in the line drawings, Figs. 1 to 5, I designed some few years ago.

For every size of shell trimmed by hand an arbor has to be made as in the case of the semi-automatic; very often new cutters and followers also. In the case of the machine shown it is necessary to provide an arbor, a shuttle and a sheet-metal magazine tube, explanation of which will be found in this article.

Referring to the drawings, Fig. 1 is the plan; Fig. 2 is a section through *A A* of plan, Fig. 1.; Fig. 3 is a section through *X X* of Fig. 1; Fig. 4 is a section through *Y Y*, Fig. 1; Fig. 5 is a detached view of the magazine shuttle, not shown in any of the other views. The details of the machine are lettered the same on all views so that the reader will readily see their location and relation to each other.

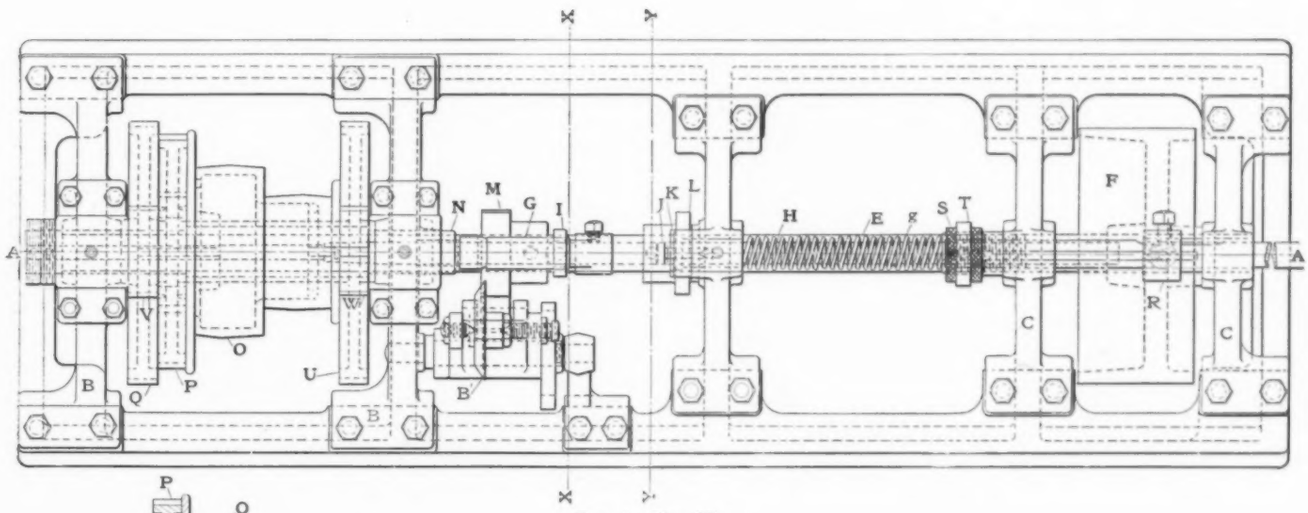


FIG. 1. Plan View

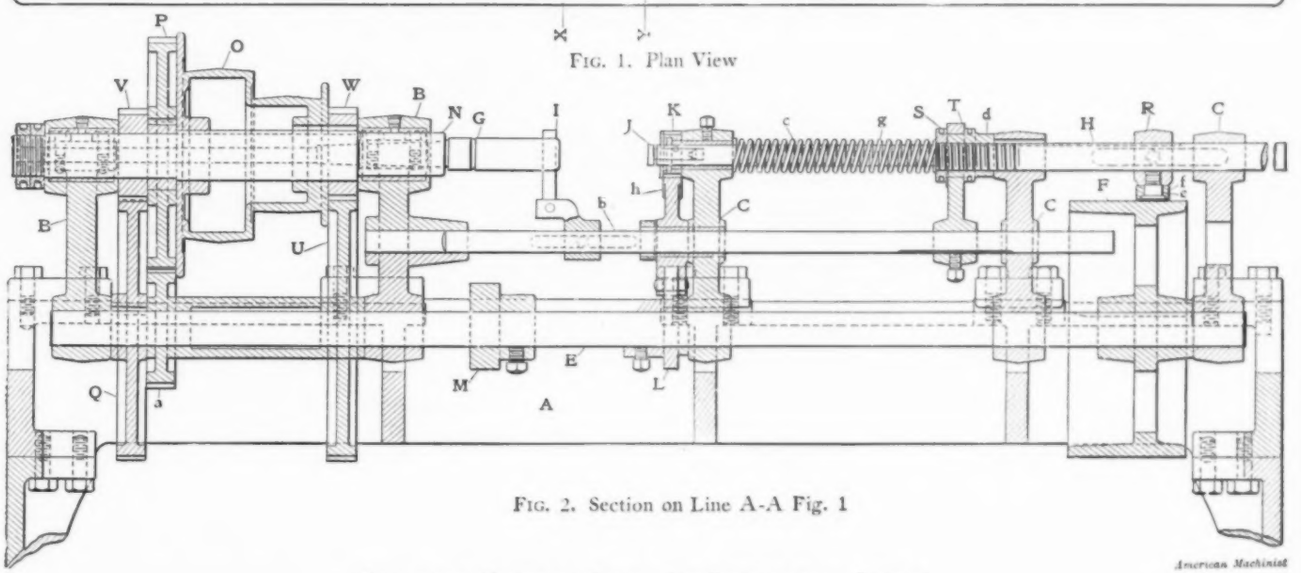


FIG. 2. Section on Line A-A Fig. 1

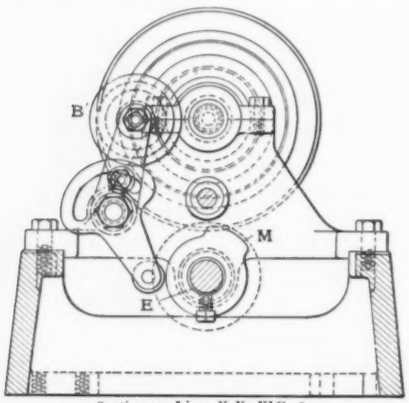
American Machinist

AUTOMATIC TRIMMING LATHE FOR SHEET-METAL SHELLS

THE DRIVE AND CAM SHAFT MECHANISM

Referring to the plan, Fig. 1, *A* is the main frame or bed of the machine, at the left of which the head brackets *B B* are mounted. Running in plain babbitt bearings in *B B* is the drive spindle *N* on which is keyed the two-step cone pulley *O*. On the right-hand end of this is screwed and doweled the small driving pinion *W* which engages the large quill gear *U*. The small quill gear engages large gear *P* to which is fastened pinion *V*, both running free on spindle *N*. Pinion *V* in turn drives gear *Q* keyed to cam shaft *E*, thus the desired speed for the cam shaft is obtained from one belt drive.

At the right-hand end of *A* the three brackets *C C C* are mounted, carrying



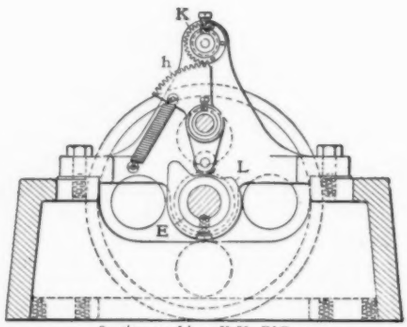
Section on Line X-X, FIG. 1

FIG. 3. THE CUTTER OPERATING MECHANISM

the cam shaft *E* and the two push rods, *H* being the follower rod, and *b* the shedder rod. Keyed to the right-hand end of the cam shaft is a drum cam, provided with suitable cam faces (not shown), and engaging with the cam *F* is a roll *f* attached to collar *R* by shoulder screw *e*. Collar *R* is adjustable for different lengths of shells. Mounted on follower rod *H* is a threaded sleeve *d* to which is fastened the yoke *T*, by means of the spanner nut *S*, *T* in turn being secured to shedder rod *b*, by means of a set screw, as shown. The shedder *I* fits over trimming arbor *G* and is held on the shedder rod as shown, thus providing means of adjustment for different lengths of work. The lateral movement is obtained from the cam drum, the cam faces on which are made of sufficient length and pitch to do all work within the range of the machine, while all over travel is taken care of by means of parts *d*, *R* and *I*.

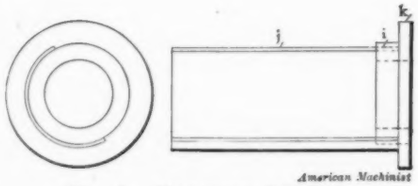
THE MAGAZINE FEED AND THE CUTTER

Inserted in the end of rod *H* is the follower *J* which is retained by a small pin and runs on a 60-degree center. Over *H*, and a press fit in bracket *C*, is a shouldered sleeve, running free on which is a gear segment *K*, to which is fastened the shuttle, Fig. 5. Mounted over *b* is another gear segment *h* which is retained by means of a collar and bush. In the lower end of *h* is mounted a roll which engages with a cam *L*, on the cam shaft, and is held against the cam by means of a spring as represented in Fig. 4. In action the cam *L* engages the roll in *h*, thus giving an oscillating movement to segment *K*, and the shuttle, Fig. 5, over which is mounted the magazine tube, not shown. This tube is not shown, but is suspended over the shuttle by a tray, from which the operator feeds the work into the tube. The lower end of the tube fits around the shuttle, the shell being removed from the magazine by the oscillating movement of the shuttle and gear segments *K* and *h*, and the follower rod



Section on Line X-Y, FIG. 1
American Machinist

FIG. 4. MECHANISM FOR OPERATING FEED SHUTTLE



American Machinist

FIG. 5. MAGAZINE SHUTTLE

shoves the shell from the shuttle over arbor *G*, which is provided with suitable cutting edge. The cutter shown at *B*, Figs. 1 and 3, is brought into action by means of cam *M*, mounted on cam shaft *E*, the trimming being done by this circular cutter and the cutting edge on the arbor. The return movement of the push rods strips the shell, and clears the way for the next shell, a finished shell being produced at each revolution of the cam shaft.

The cutter is provided with means of adjustment in each direction, swings on 60-degree centers, and is held against its cam by means of a spring. A plain slide is provided in order to use a knife tool when doing work too heavy for the circular cutter; where possible to use it the circular cutter will give the best results.

SHUTTLE DETAILS

An explanation of the shuttle will probably be of value to the reader. Referring to Fig. 5, *k* is a shouldered washer provided with means of attachment to gear segment *K*, Figs. 1, 2 and 4. Sweated to *k* at *i* is a semi-circular piece of sheet metal, made slightly larger than the outside diameter of the shell to be trimmed, the opening in which allows the shell to drop from the magazine tube, and a partial rotation of which closes the lower end of tube, and the shell is then carried out and onto the arbor by means of the push rod *H* and follower *J*, Fig. 2.

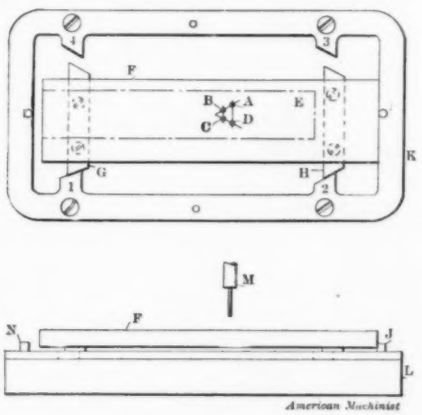
The machine has a capacity of from 40,000 to 60,000 shells per day, and a range up to 3 inches in diameter by 3½ in length. The time required to set for each size does not exceed three-fourths of an hour; the extra parts required are a small item, and the quantity and quality of the work more than pay for the upkeep.

A Drill Jig

BY H. M. DENYES

The drill-jig guide, shown in the accompanying cut, is for use on small drill presses and knee-feed drill presses, where the holes *A*, *B*, *C* and *D* are grouped in a manner similar to that shown.

The guide *K* is fastened to the table *L* of the drill press by four screws and



American Machinist

A DRILL JIG

two dowels. The legs *G* and *H* are screwed on the bottom of the jig *F*, these legs hold the jig off the table. With the jig in the position shown, the hole *B* is drilled. The jig is then moved back against the stop pin *N*, the jig still being held against the arms 1 and 2 of the guide *K*, and the hole *A* is drilled.

The jig is then moved over against the arms 3 and 4 but still holding it against the stop pin *N*, the hole *D* is drilled. The jig is moved forward against the stop pin *J*, still holding jig against the arms 3 and 4, and the hole *C* is drilled.

The work *E* is then removed and another piece put in, which is held by a clamp screw, not shown.

MODERN SUBMARINE TORPEDO BOATS

Complicated Mechanical Devices Solving a Problem of Much Historic Interest

BY R. S. BAYARD

History tells of many attempts from very early times to solve the problem of submarine navigation, but it is in the present day only that a practical boat which can travel any distance under the surface of the water, has been constructed. This takes the form of the modern submarine torpedo boat.

Even though as short a time ago as the Civil War, several attempts to use submarine topedo boats are recorded, the boat proper is somewhat like that of a cigar while the lower part of the superstructure on top adds an appearance not unlike an ordinary boat upside down. A portion of this superstructure is flat and when running above the surface of the water this flat section gives a little deck space for standing room.

Motive Power

When on the surface these boats are driven by gasolene engines and when submerged the motive power is obtained from storage batteries and electric motors. Some boats recently completed; that is, the "Narwhal," the "Salmon" and the "Grayling" have a displacement of 360 tons and are driven by two 6-cylinder gasolene engines developing 600 horsepower delivered to twin propellers. These boats are of considerable size, being 135 feet long and their surface speed with the gasolene engines is about 13 knots while their submerged speed when running with the storage batteries is more than 10 knots. These boats are the largest submarines that have been built so far, but there are many other smaller ones in commission.

The Power Plant

It would be hard to conceive of a power plant more compactly arranged and with which more different operations can be performed, than with the combined gasolene-electric machinery which is installed on one of these boats. In the tail shafts leading to the propellers, there are several clutches and they are so arranged that the gasolene engines may drive directly to the propellers or, disconnecting the propellers, a gasolene engine may drive a motor as a dynamo, generating electricity to charge the storage batteries. Also, the gasolene engine may drive an air compressor to compress air

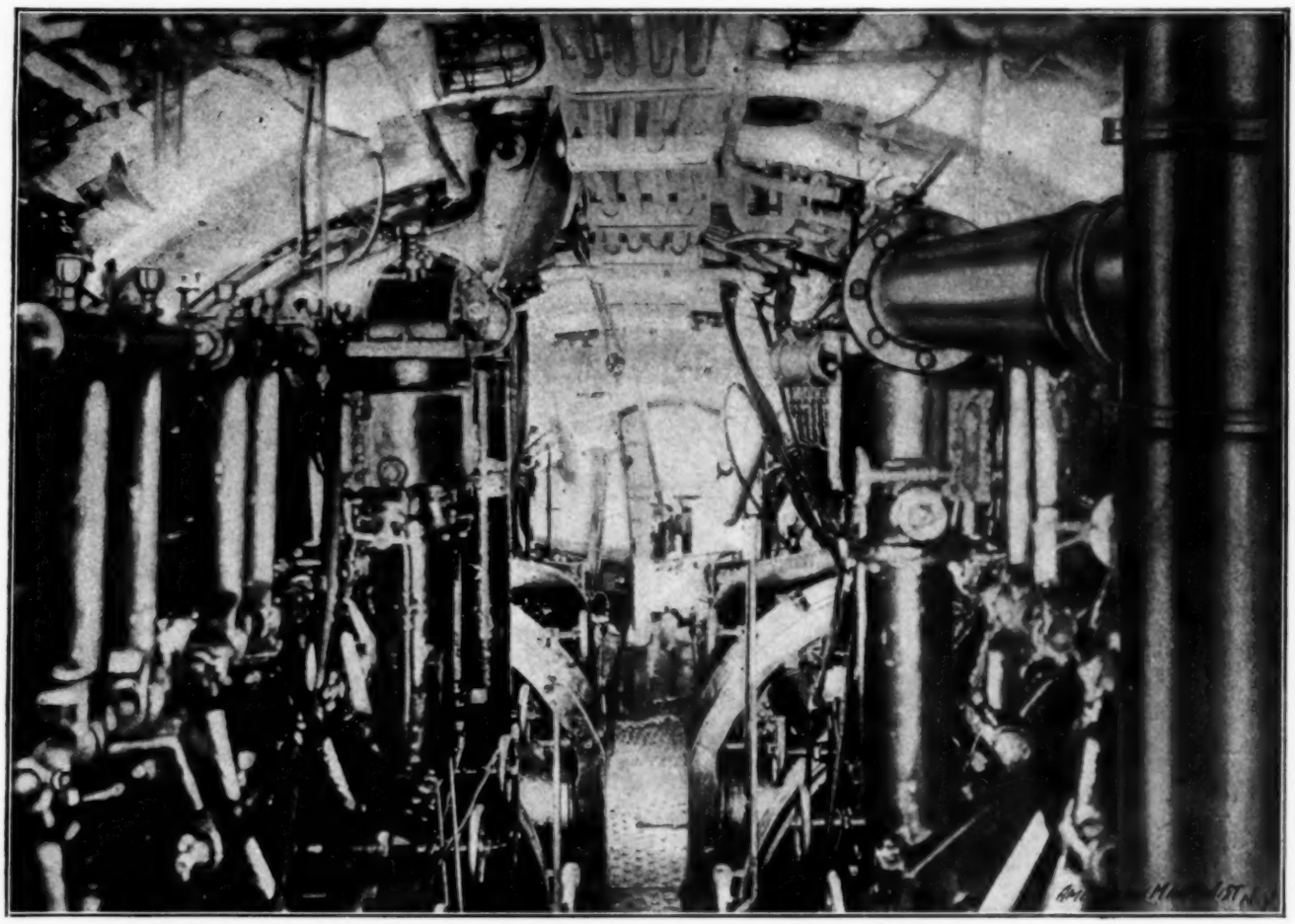


FIG. 1. INTERIOR OF ENGINE ROOM OF SUBMARINE TORPEDO BOAT. SIX-CYLINDER GASOLENE ENGINES ON EITHER SIDE IN FOREGROUND. MOTORS AND AUXILIARY APPARATUS BEYOND

results obtained were purchased only with the lives of the operators.

At the present time, all of the principal navies of the world are equipped with submarine torpedo boats of one type or another. One type of boat used by the United States navy is the "Holland," as built by the Electric Boat Company, at Quincy, Mass., and the accompanying illustrations show the general appearance of these vessels.

It will be seen that the shape of the

up to 2500 pounds pressure. It may also drive a bilge pump to pump out the ballast tanks or to remove water which may leak into the vessel.

Further than this the engines may be entirely disconnected, and the electric power from the storage batteries used to drive the motors, turning the propellers and driving the boat under the surface or, disconnecting the propellers, the motors may be used to operate the air compressor or the bilge pump. Two other uses may be made of the motors, that is, "cranking," or starting and reversing.

Ballast Tanks

Just inside the lower half of the shell of the boat in the midship portion water-ballast tanks are arranged, these tanks being both at the sides and bottom. When these tanks are empty the vessel weighs 20 per cent. less than an equal volume of water and consequently has plenty of incentive to stay at the surface.

By adjusting the amount of water in the ballast tanks the boat may be made to float high or low or sink entirely. For diving under service conditions enough water is admitted to the tanks to leave about 700 pounds positive buoyancy, and in will float just awash. Then by means of the horizontal diving rudders at the stern, the boat may be made to dive below the surface and become completely submerged. Steering below the surface is accomplished by both horizontal and vertical rudders.

There is another ballast tank known as the adjustment tank and by carefully graduating the amount of water admitted to it, the weight of the boat may be so accurately adjusted that it can be made to float at almost any predetermined depth when not in motion.

In the bow and stern there are what are known respectively as the forward trimming tank and the after trimming tank. By adjusting the quantity of water ballast in each of these two tanks, the trim or inclination of the boat in the water may be nicely regulated.

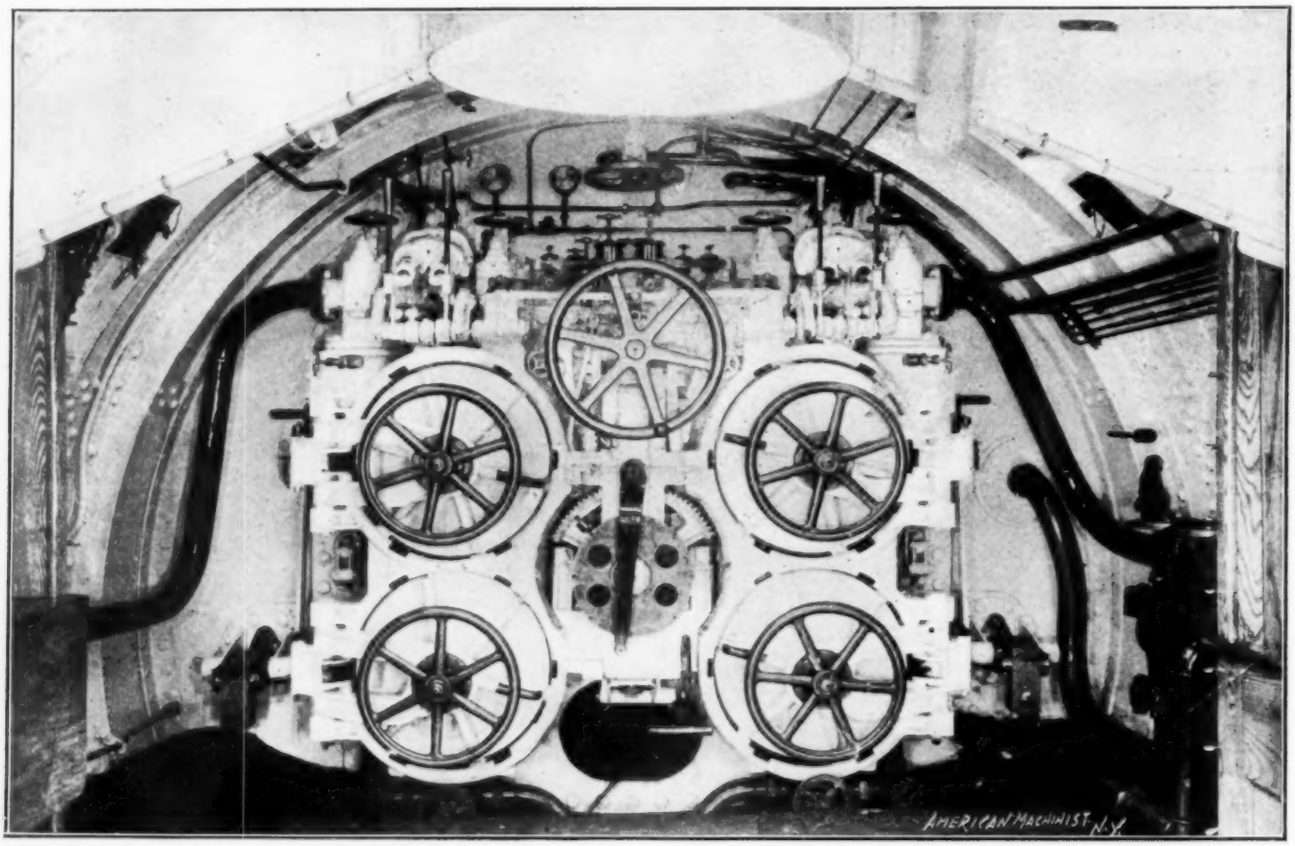


Fig. 2. Torpedo Room of Submarine, Looking Forward. Central Handwheel and Crank Control Bow Cap. Four Side Wheels Open Breech Doors of Torpedo Tubes. Levers and Piping for Operation of Tubes

The Part of Compressed Air

There are several different means of getting the water out of the ballast tanks, although the usual method is by displacement with compressed air. When at the surface, the air compressor is run to charge air to 2500 pounds pressure and bottle it up in seamless steel bottles, thus storing a large quantity of air in a small space. Except for charging the torpedoes which use air at 2250 pounds pressure, this bottled air is reduced by a reducing valve to about 100 pounds pressure in a piping system extending throughout the boat. This pressure serves for clearing the ballast tanks and also for shooting the torpedoes out of the torpedo tubes. This air is also used for ventilation purposes when submerged. For long submergences it is, of course, necessary to get rid of the vitiated air in the boat and as this has to be done against the outside water pressure, which depends upon the submergence, a small "foul air pump" is provided. This device forces the vitiated air out of the boat and into the sea. Under ordinary circumstances, the pressure within the boat is maintained at just about atmosphere, this being determined by a barometer for that purpose.

Necessity for resisting the outside water pressure when submerged has considerable to do with the shape of the vessel and the Government requires that before acceptance these submarine torpedo boats shall be sunk to a depth of 200 feet below the surface of the water. This brings the pressure to about 90 pounds per square inch over the entire surface of the structure. On this test, which is made by lowering the boat from a derrick at sea, without any occupants, a pantograph measuring device is used which records the amount of the deflection of the shell of the boat due to this heavy pressure.

Seeing around a Corner

As seen in all the illustrations, above the small deck on the surface of the boat there is a further superstructure known as the conning tower. The main por-

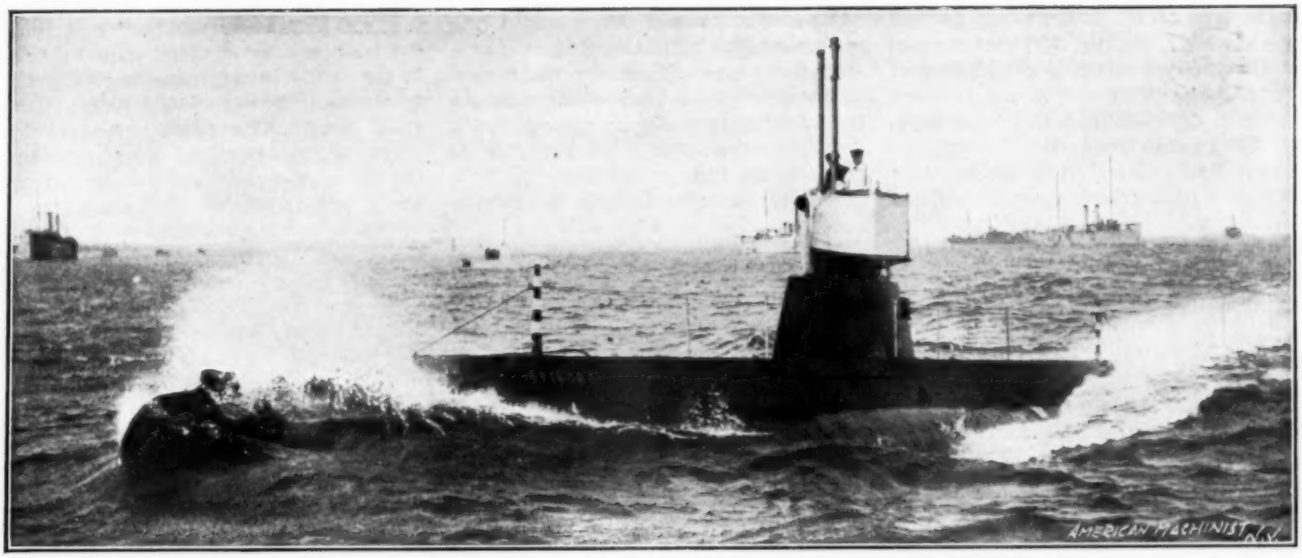


FIG. 3. THE "STINGRAY" AT FULL SPEED ON SURFACE

tion of this conning tower is a round tube in which the commanding officer stands. In front of him there is the eye piece of what is known as the periscope. A tube about ten feet long projects up through the top of the conning tower and by means of reflecting prisms both at the top and the bottom, together with an object glass at the top and suitable eye pieces at the bottom, the officer in the conning tower can see what is going on around him as long as the object glass at the top of the periscope is above the surface of the water. By means of a handwheel he can turn this periscope to look around the horizon.

For ordinary purposes, the periscope is provided with lenses of such design that the operator sees external objects in exactly the same size as he would see them with his naked eye if he were at the surface. In this way be is able without difficulty to judge distances with considerable accuracy. Beside this, however, there is a telescope attachment to the periscope by which the image is magnified just as if the observer were standing at the surface of the water and looking about him with a binocular. This, of course, is of great assistance in looking at objects at a distance. Each of the newer submarines is now provided with two periscopes, one for the commanding officer, which may be turned around for observation on all sides and one for the helmsman, this latter periscope being suitable for looking straight ahead, in the direction of travel only. In this way, while the commander may be observing on all sides, the helmsman can at all times see exactly what is in front of him.

THE CONTROL

At least five men are required to operate the boat, all working in unison. The officer in the conning tower has speaking tubes before him and can talk to any of the different men engaged in the running of the boat. One man in the body of the boat just forward of the center, operates a wheel which controls the horizontal or diving rudder. Before him are two gages giving directly the depth of submersion of the boat by means of the pressure of the exterior water up to the surface. Two gages are provided, simply to act as a check one against the other and in case one should be out of order. He can also see several inclinometers or levels to assist in maintaining an even keel.

Just forward of the conning tower, in the body of the boat, a man is stationed to operate the vertical rudder which steers the vessel like any ordinary ship. Another man in the after section of the boat acts as engineer to control the machinery. In the forward part of the boat still another man controls the torpedo apparatus.

SHOOTING TORPEDOES UNDER WATER

Shooting the torpedoes under water is a problem which is solved in rather a novel manner. There are four torpedo tubes

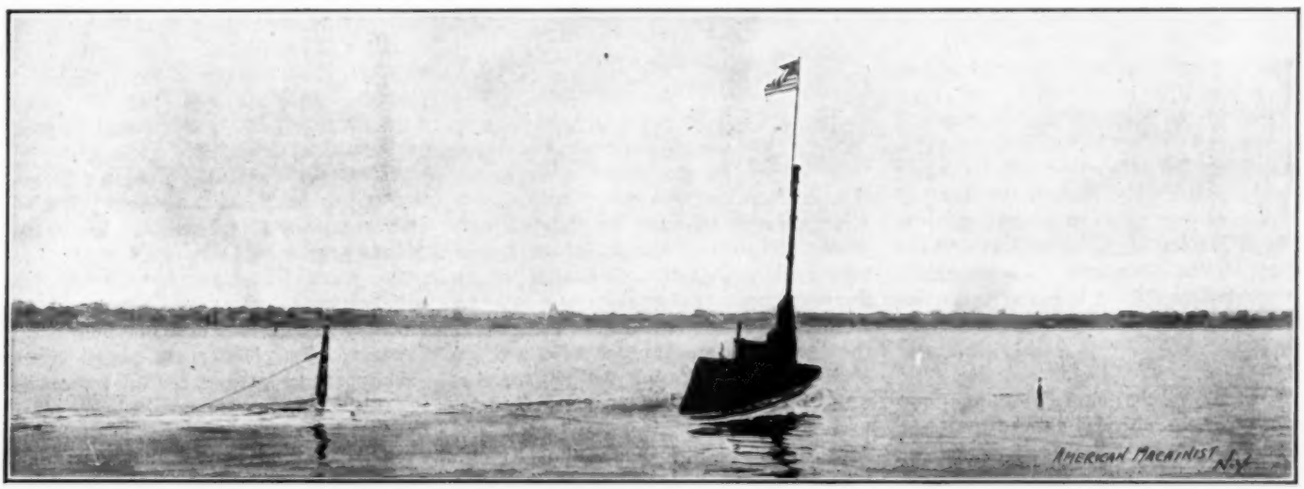


FIG. 4. THE "OCTOPUS" IN THE ACT OF DIVING

in the bow of the boat proper, parallel to and symmetrically arranged around its axis. A short section of the bow of the boat constitutes a revolving bow cap which is separate from the main body, and this revolving cap is made with two holes through it, a little larger than the diameter of the torpedo to be fired. These

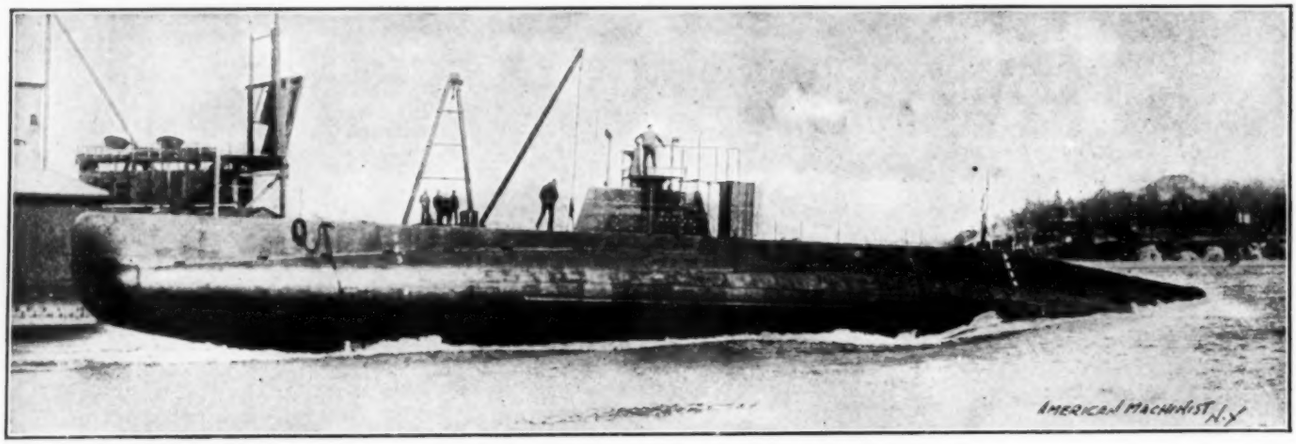


FIG. 5. LAUNCHING OF THE "NARWHAL." SHOWS BOW CAP AT LEFT

two holes are diametrically opposite to each other and on the other diameters there are two round seats of such size as to cover the torpedo-tube holes in the bow of the boat proper. The cap is so arranged that it may be revolved on its axis which is the axis of the ship, the cap being first slid forward a little, bringing its back surface away from the front of the vessel to a slight extent. Revolution of the bow cap brings the holes through it opposite any two of the four diametrically opposite torpedo tubes on the inside of the boat, so that while two of the torpedo tubes are open to the outside water through the holes, the other two are tightly closed against entering water by the round seats on the back surface of the cap. The tubes which are open are immediately filled with water from the outside but this water cannot get into the boat because there is a cover on the inside end of each tube. For inserting torpedoes into the tubes the inside covers are removed but not before the outer ends have been covered by the seats on the bow cap and the trapped water blown out by compressed air. This blowing out of the water would considerably disturb the trim of the submerged boat, so a compensating tank is provided inside the boat and the water in the torpedo tubes is simply transferred to this, in this way maintaining the weight approximately constant.

GETTING OUT

Now, as to the vital question, "how do you get out when anything happens?" Of course, when the boat is submerged all hatch openings are tightly sealed by means of rubber gaskets and pull-down bolts. On the most modern boats, the hatch covers are, however, arranged with springs so that by releasing from the inside the caps will fly up on hinges. Furthermore, each hatch cover is at the top of what is really a tube projecting down into the upper portion of the air space of the body of the boat.

Suppose first that a hole is made in the bottom of the vessel and the water is leaking in. The inflow of water will compress the atmosphere inside of the boat until this pressure equals the pressure of the water on the outside, and this compressed air will occupy the top portion of the vessel's hull, where the men's heads would be while standing in the rising water. With equal pressures inside and outside the release of

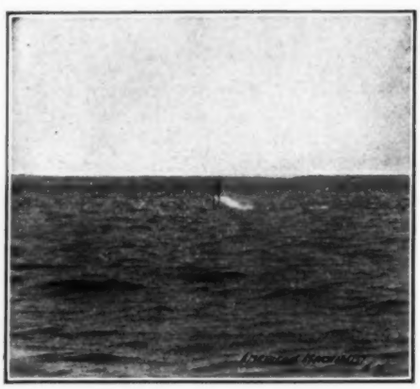


FIG. 6. ALL THERE IS TO SEE AND SHOOT AT

the catches on the hatch covers will allow them to fly open by their springs. Water will then of course fill the hatch-tube opening, but air will be trapped by the lower ends of the tubes leading down from the hatches and cannot escape out through the hatch because of the water seal at the bottom of the hatch tube. This gives time for the men, one by one, to duck their heads down under the surface of the water in the boat, climb through the hatch tube and swim out to the upper surface. This method of escape could also be used in case, for any reason, the boat could not be raised from the bottom, even if there were no hole in the hull. In this case the air pressure within the boat would be raised to equal the outside water pressure by means of the bottled-up compressed air. On the latest boats three escape hatches are provided, besides the conning-tower hatch, which is provided with two doors to form an air lock. The spectacular method of being "shot" out of the torpedo tube is said to be dangerous, unnecessary and melodramatic.

Four torpedoes are carried by the more modern of these little boats; that is, one in each of the four torpedo tubes. Gasolene fuel is stored in tanks underneath the torpedo tubes in the forward portion of the vessel.

THE SHIP DESIGNERS' PROBLEM

From this description it would not seem to be a very difficult matter to build a boat that will operate in a satisfactory manner beneath the surface of the water. It must be remembered, however, that this result has been arrived at only after years of study and experiment and even lately, with some of the modern boats of different design it has been found that it is very difficult to maintain equilibrium when under the surface. These unstable boats were not properly designed and had a strong tendency to pitch. It was found on trial to be almost impossible even with the most careful manipulation of the diving rudders to keep them on an even keel or at an even submergence, at a speed of only about 5½ knots an hour. In some boats that have been tried this variation in submergence is said to have amounted to 20 feet or more in a short distance. The higher the speed when submerged the greater tendency there is to pitch and consequently the more danger there is of the boat turning end over end and going to the bottom to its destruction. Many different methods of control have been tried to overcome these difficulties with the result that the boats

now being purchased by Uncle Sam are able to run along under the water at the high speed of over ten knots an hour with remarkable stability and a variation in submergence of not more than two feet, for continuous running.

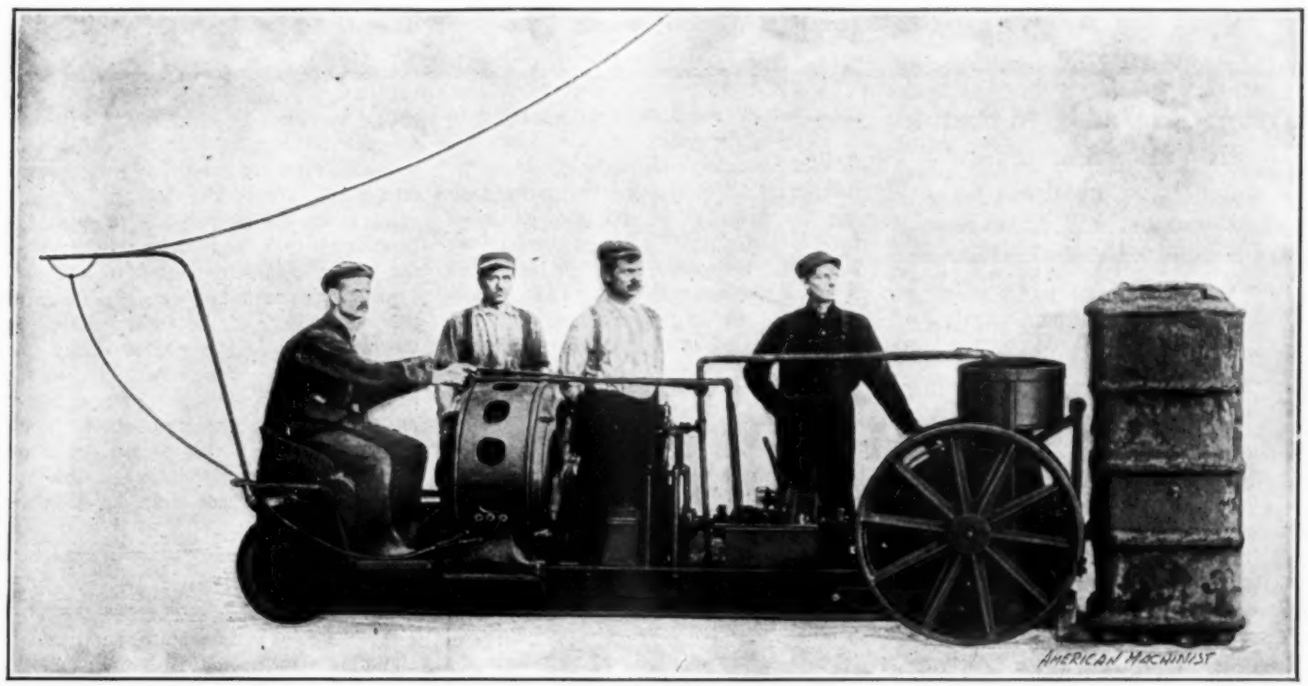
Radius of Action

As to radius of action, with the amount of fuel which can be stored on board it has been demonstrated that some of the boats recently furnished the Government are able to run on the surface to a distance of about 700 miles at an average of over nine knots. If this speed were reduced to seven knots the range would be nearly 1200 miles. When submerged these boats when running at full speed of about 10 knots are capable of running for over an hour continuously, and if this speed is reduced to about half, the radius of action when submerged would be nearly 80 miles. This seems like a large discrepancy at the slow speed, but it must be remembered that the power required to drive a ship through the water is about proportional to the cube of the speed. In other words, twice as fast requires eight times the power.

It is often asked, "How long is it possible to stay under the water in one of these submarines?" As far as personal comfort is concerned, with the steel bottles fully charged with fresh compressed air, it is possible to live in one of these boats beneath the surface of the water for several days at a time without the slightest inconvenience.

Electric Charging Truck in Malleable Foundry *By C. A. Stone*

The accompanying picture shows an interesting "pot" truck in use at the plant of the Marion Malleable Furnace Company, Marion, Ohio. In malleable-furnace work the parts to be treated are put in covered pots and then placed in a furnace in which they are subjected to a heat treatment. When cold it is an easy matter to handle them, but after they have been heated it is a very different proposition. Several different schemes have been tried in this plant for handling the hot pots. These have included trucks operated by steam and compressed air, but both methods have their disadvantages and the electric truck described below has been put in use.



Electric Truck for Handling Annealing Boxes in Malleable Foundry

This truck is made up of structural-steel members supported by three wheels. The two at the front are for driving, while the smaller one at the rear is for steering. Mounted near the rear of the truck is a standard "squirrel cage" induction motor and a standard potential starter.

The motor drives a main shaft, located between the I-beams forming the sides of the truck, through suitable gearing. On this shaft is a clutch, somewhat like those used on automobiles, by which the traction wheels at the front can be driven in either direction or cut out entirely. After being started the motor runs continuously. Power for the motor is obtained from an overhead trolley supported by the roof trusses. A small cart-shaped affair runs along on the trolley wires and gives the necessary electrical contact.

The elevating hooks that lift and support the pots are located at the front end of the truck. These hooks are pivoted to the truck at a suitable point, as shown in the halftone. A cylinder operated by compressed air and connected to the hooks by rods, lifts or lowers the load of pots. Air for this cylinder is furnished by a small piston air compressor driven from the main shaft by an eccentric.

The operator rides at the rear of the truck and has complete control of it at all times. The range of operation is limited only by the size of building or locating of trolley wire.

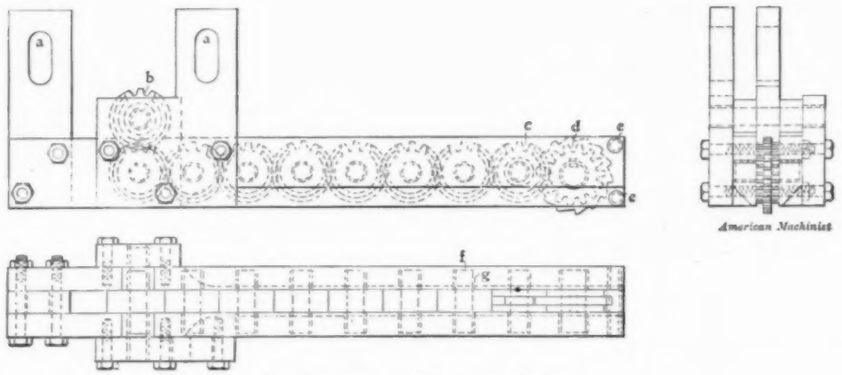
A healthy growth in the various electrical industries during 1909 is pointed out by the *Electrical World* in calling attention to the obvious fact that a great many more electric automobiles have been built; that wireless telegraphy is in more widespread use; that electric heating and cooking devices are in greater variety and popularity; that electric motors have been applied to novel purposes; that new lamps have come in to broaden the domain of electric illumination. It estimates apparatus and income from service during 1909 at $1,500,000,000.

A Practical Internal Milling Device

By E. W. Knowlton

Internal grooving has often been done in the shaper and the rifling machine. I had never thought of a milling device for such work, until I got up against a job that required a number of grooves, similar to keyways except that their length and depth were very particular, they must also not break out at the open end of the job and could not strike the solid end; these conditions added considerably to the difficulties.

The accompanying sketch will show the device used, and although it was made from scrap material it does as good a job now as it did when it was new, and has milled hundreds of grooves.



AN INTERNAL MILLING DEVICE

Referring to the cut the two slots *a* slide over the studs in the arbor support and the whole thing is raised until the gear *b* meshes into a gear on the arbor.

The gear *c* has a groove cut in its center to allow the cutter to clear. The cutter and two twin gears are keyed together as one solid piece. Two spacing studs *e* are riveted in place.

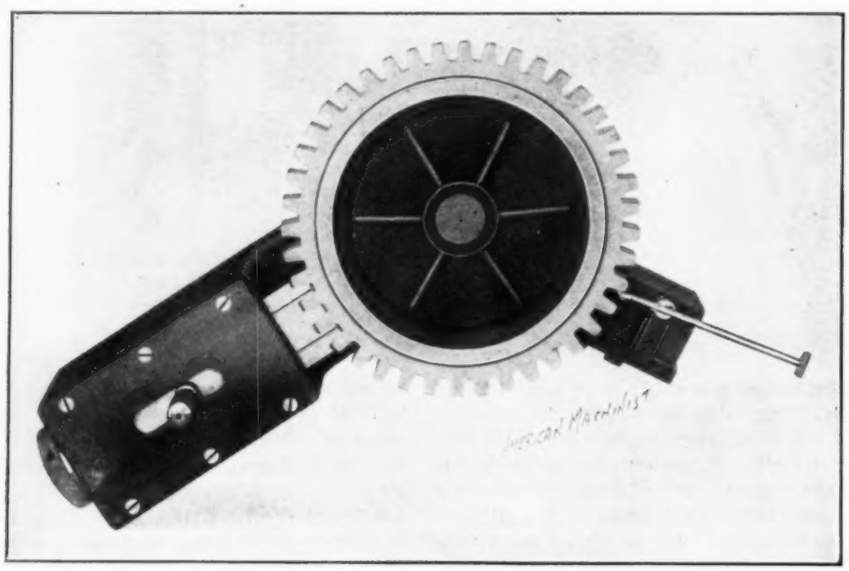
It will be noticed that the cutter cuts toward the arbor, this is very important, as it prevents gouging. The shaft *f* runs in the brass bushing *g*.

I used a speed of 140 revolutions per minute for the cutter and a slow feed which gave us the best results in cast iron. The grooves were ⅛ inch wide 3/32 inch deep and 5½ inches long in tubes 1½ inches diameter.

Testing an Index Wheel for an Automatic Screw Machine

EDITORIAL CORRESPONDENCE

As will be recalled by most of our readers, the Lester multiple-spindle automatic screw machine, built by the Davis Sewing Machine Company, of Dayton, Ohio, is equipped as described at page 975, Volume 32, Part 2, with an index ring for the spindle-carrying cylinder, in the form of a gear ring of fairly coarse pitch with hardened and lapped teeth, which are engaged with a three-tooth index block whose movements in releasing or reëngaging the index ring are controlled by cams on a disk at the head end of the machine. An interesting device for testing the accuracy of this toothed index ring is illustrated by the accompanying halftone where the method of inspection is so clearly brought out as to make unnecessary any long description.



TESTING AN INDEX WHEEL FOR THE LESTER AUTOMATIC SCREW MACHINE

As indicated in the engraving, the index ring is mounted upon a disk adapted to rotate upon a central stud in the fixture and in line with this stud is a master locking bolt with three teeth as shown, which bolt may be moved longitudinally into mesh with the gear ring and set up properly by a graduated knob at the rear end of the guide in which the bolt travels, so that the locking bolt is located with the same pressure each time it is brought into place. With the bolt properly in place it should be possible to push the plug down into its seat in a hole below the bolt, thus insuring positive and uniform engagement between the teeth of the index ring and the locking bolt. At the other side of the toothed ring a test indicator is applied as shown, and as the ring is indexed around to the different positions any inequalities in the teeth are revealed by the action of the indicator, which is brought into contact with the work at a point on the teeth about on the pitch circle.

Titanium

An item of interest to metallurgists and others connected with the steel industry is extracted from a report giving the results of experiments on the production of comparatively pure titanium published in *Stahl und Eisen*: The oxide of titanium was reduced by aluminum, and a product obtained containing 53.72 per cent. of titanium, 45.17 per cent. of aluminum, and 1.31 per cent. of silicon. This material was compressed under great pressure, saturated with hydrogen gas, and then electrically fused in a vacuum so that the aluminum distilled off. The melting point of the titanium thus obtained was found to be between 2200 and 2400 degrees Centigrade (3992 and 4352 degrees Fahrenheit). The pure, fused titanium was silver white in color, and contained 97.41 per cent. of titanium, 1.56 per cent. of hydrogen, and 0.30 per cent. of carbon.

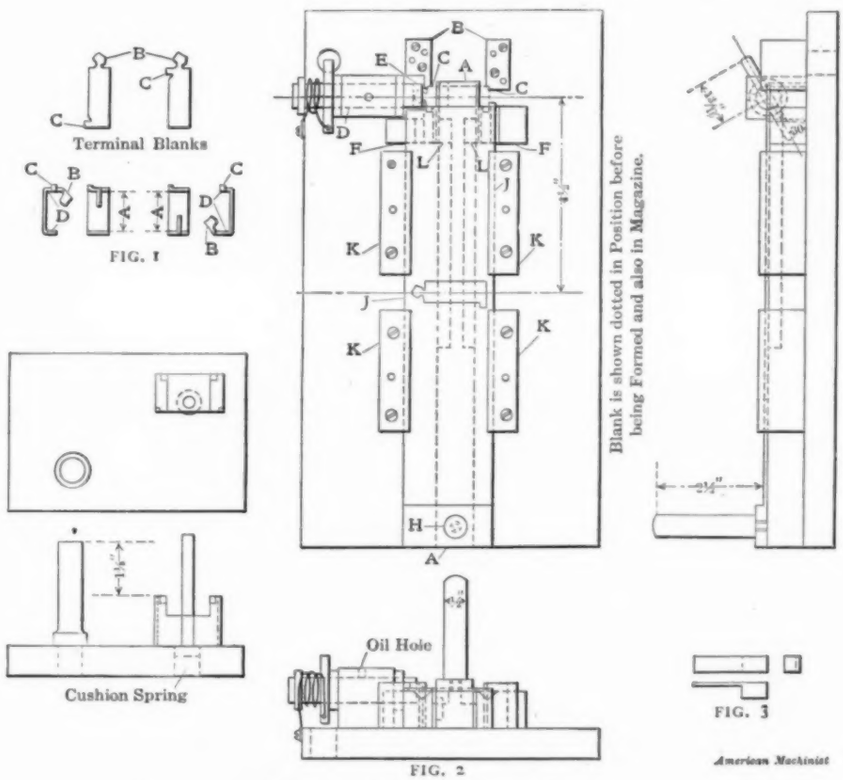
LETTERS · FROM · PRACTICAL · MEN

Concerning the Details of making things in machine shops, from the first sketch to the sale

A Forming Die for Terminals

Some time ago I had occasion to make a forming die for the pieces shown in Fig. 1. They are two separate blanks and I desired to bend both of these pieces with the same die and also have as safe a die as possible.

Expense was a consideration and I decided on the one shown because it is efficient and low in price.



FORMING DIES FOR TERMINALS

I took a piece of cold-rolled steel about 10x6x⅝ inches and used it as my base. Running all but about 2 inches of the length of this I fastened, on the center line, the strip *A*, the width of which is the dimension marked *A* in Fig. 1. The hight of this I made about ¾ inch, just enough to allow me to work with it easily. At the short end of this strip I put the blocks *B*, cut out at *C* the shape of the blank thus forming a stop for the blank as it is thrust forward. At one side of *A* I put *D*, which is a piece of steel ½ inch in diameter and has its bearing in another block 1¼ inches long. *D* is held in place by a washer at either end of the block, thus preventing any slipping or sliding. On one end of *D* is the slot *E* which is just large enough to allow *B*, Fig. 1, to slide into it. The piece is so placed that when the blank is against the stops, its center line will fall directly on the center line of the blank. At the other end a 3/16-inch pin is passed through *D* at an angle of 30 degrees to the base and at the same end a spring is so arranged—with stops—as to hold the slot *E* when in its normal position absolutely horizontal. The corners of the slot are slightly rounded so as to enable the blank to slide in easily. Then in front of *D* and on either side of *A* I put two V-bolts *F*, which are placed so that the upturned lug *C*, Fig. 1, will fall on the angle. There must be two of these, as the lug falls at different places on the two blanks. The bending of *D*, Fig. 1, was simple enough; all that was required being a simple forming punch cut away so as to clear the upturned lug. The punch was simple enough except for the rod which is backed by a spring resting in the punch holder. This was to hold my blank from twisting while the blade was being formed.

Placed about 4½ inches from the center of the die, just enough to clear the ram of a press, I put a magazine. Running beneath this I put a strip of steel *J*, a trifle less than the thickness of my blank, and cut out the end so it would fit either of the two blanks. In pushing it forward it acted both as a guide and a feed. Fastened to the base I put the blocks *K* which were used as guides for *J*. On one end of *J* I put the handle *H* to enable it to be easily moved, and at the shaped end I put two strips *L* which acted as knockouts for the already formed blank. Their shape may be seen in Fig. 3. They slide in grooves cut out of *A* and one end of the slot or groove acted as a stop and prevented pulling *J* all the way out. Another slot was cut in the side of *A* to take the blank *B* after it was formed, otherwise it would strike the solid die.

The whole worked as follows: The handle *H* is drawn out until *L* strikes the stops. At this position it clears the magazine. It is now pushed forward and the end comes in contact with the blank and being the same shape, it guides the blank forward until it strikes *E*. The two fingers *L* going before, push the terminal which has been formed out of the die. The punch now comes down and holds the blank firm with its spring plunger and continuing down strikes the 3/16-inch pin on the end of *D* and forms the blade. At the end of its stroke it forces down the parts marked *D*, Fig. 1, and in doing so forces the lug up on the angles of the blocks *F*, thus making a complete form. The guide is again thrust forward and the operation goes on.

JOHN A. RUTTER.

Philadelphia, Penn.

Coefficient of Friction for Steel Shafts in Hard Wood Bearings?

Recently I had occasion to figure the friction horsepower of some steel shafts on hard-wood bearings, both shaft and bearings being submerged in fresh water. Kent and Trautwine were the only reference books accessible and they seemed to give coefficient of friction somewhere between 0.25 and 0.125, both of which seem high for the case in point. Can any of your readers give recent data, say not over 5 years old, on this matter of

submerged bearings with water lubrication only, as well as the same with tallow or paraffin applied under water? If so, it will be appreciated.

Morristown, Penn. R. S. WILLIAMS.

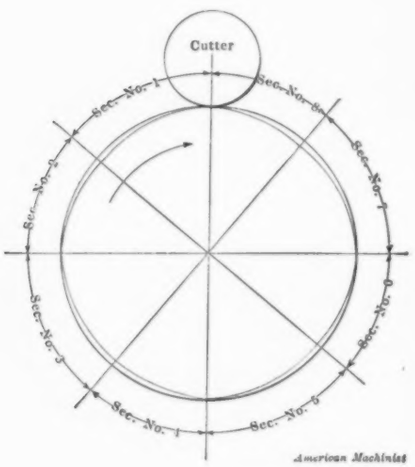
Milling Disk Cams

The object of this article is to show how the job of milling cams of the class indicated may be simplified, and the movements tabulated to enable the milling-machine operator of limited experience to do the work. This idea is useful on many other milling operations, and in my experience as foreman has no doubt saved a number of expensive pieces from the scrap pile, and has helped to develop some good milling-machine operators besides.

A four-point cam was required with 0.015 inch rise in 1/9 of the circle, and a decline or return to original position in the balance of 90 degrees. These cams were ½ inch thick, and were mounted on an arbor in the dividing head, which was set at right angles to its usual position on the milling-machine table. A ¾-inch cutter was held in the spindle collet, and centered over the top of the work. In figuring out the chart for the movements to be followed by the operator, an index plate with a 54-hole circle was selected. As 40 turns of the index crank are required to complete one revolution of the work there would be in a complete revolution $40 \times 54 = 2160$ holes. As the rise of the cam occurs in 1/9 of the circle, there would be 1/9 of 2160 $= 240$ holes in that part of the cam. The decline or return would occur in the difference between one fourth of 2160 and $240 = 300$ holes.

For the purpose of making the chart perfectly clear, the cam should be drawn as shown in the sketch. This is divided into eight sections. The first section, which is a return portion was divided into 15 divisions of 20 holes each; by raising the milling-machine table 0.001 inch for each division this section was milled. Section No. 2 is a rise, and for cutting this a little finer adjustment was required as this is the important part of the cam. It was, therefore, divided into 30 divisions of 8 holes each, and the table was lowered 0.0005 inch for each division. From the foregoing the accompanying chart or table was made, which enabled the operator to proceed without delay, and with little excuse for mistakes.

Decatur, Ill. C. G. HEILY.



MILLING CAMS

1st section,		Divide 15 Div. 20 holes each.
"	"	Raise table .001 for each division.
2d	"	Divide 30 Div. 8 holes each.
"	"	Lower table .0005 for each division.
3d	"	Same as No. 1.
4th	"	" " No. 2.
5th	"	" " No. 1.
6th	"	" " No. 2.
7th	"	" " No. 1.
8th	"	" " No. 2.

Guard for a Power Press

The accompanying halftones, Figs. 1 and 2, show clearly two views of a very useful guard for the power press, one view showing the guard in action and the other showing it closed. The chain is attached at one end to the pedal of the press and at the other to the end slat of the lattice. The other end of the lattice slides in a guide behind the flat strip. This part of the fixture is held in position by two angle strips fastened to the frame of the press.

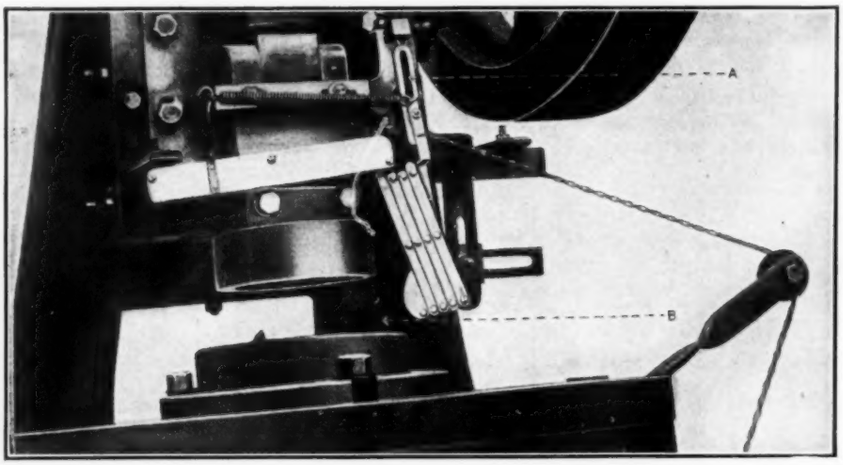


FIG. 1. POWER-PRESS GUARD WITHDRAWN

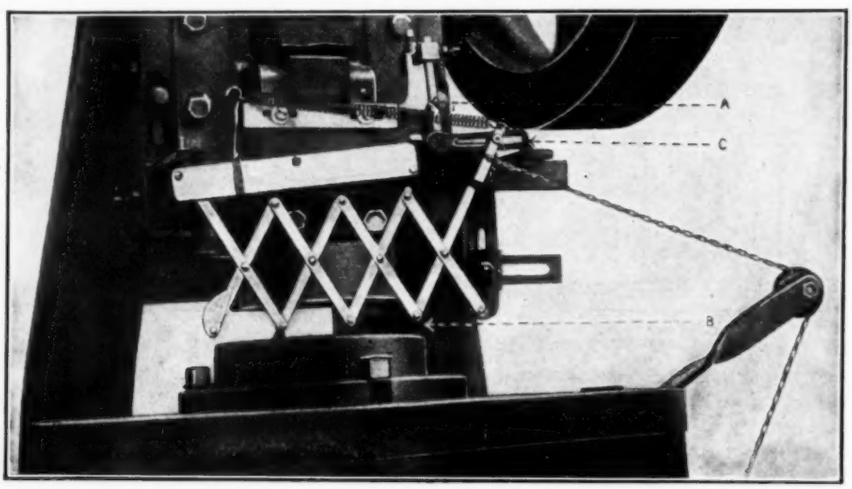


FIG. 2. POWER-PRESS GUARD IN POSITION

When the pedal is depressed the lattice opens just before the ram comes down and should the operator's hand be under the tools it is brushed aside before any damage is done. When the pedal is released the spring returns the lattice to a closed position. The adjustable rod *A* is fastened to the ram of the press and is set to strike a short piece at the back of *C* and connected to it, thus forcing the latter in a downward direction and so opening the lattice. Should the press

then through any cause repeat itself the same action takes place as when the pedal is depressed and the operator's hand is pushed out of danger before the tool punch comes down. W. HOUGH.

Wolverhampton, England.

A Kink in Hobbing Worm Wheels

We once took a job of manufacturing a large number of brass worm wheels 84 teeth 12 diametral pitch, 7-inch pitch diameter to gear with a worm 6 threads, 12 diametral pitch, ½-inch pitch diameter, at 3¾-inch centers. The angle of the worm thread was 45 degrees.

After getting the hob made, a very difficult job in itself, we got to work and smashed the hobs after about six wheels were done. The cause of the breakage was that the weight of the cut was sufficient to deflect the hob and cause the teeth to cut deeply into the wheel and smash off. We began to think out means to get over this trouble. Accuracy of contact wasn't an essential quality, as the wheels were practically no load at all. The final solution of the difficulty, and one which gave us a wheel which geared very well with the 6-thread worms was to make a hob with 10 threads and having a pitch diameter of 0.833 inch. The pitch angle was in consequence 45 degrees, the same as the pitch angle of the worms. This hob was, of course, considerably stronger than the original one we scrapped, and we were able to employ a lot quicker feed on the hobbing machine and thereby get a fair show of profit on what was originally a very fine cut job. The gears ran sweeter, if anything, than those cut with the correct hob, though of course it is impossible to assert that they had anything like the same accuracy of contact.

This kink may be found useful by those who have similar wheels to cut. It is not to be recommended in cases where the wheels have a small number of teeth, say less than 30 or 40, nor is it to be recommended for gears of larger pitch than about that on which it was employed.

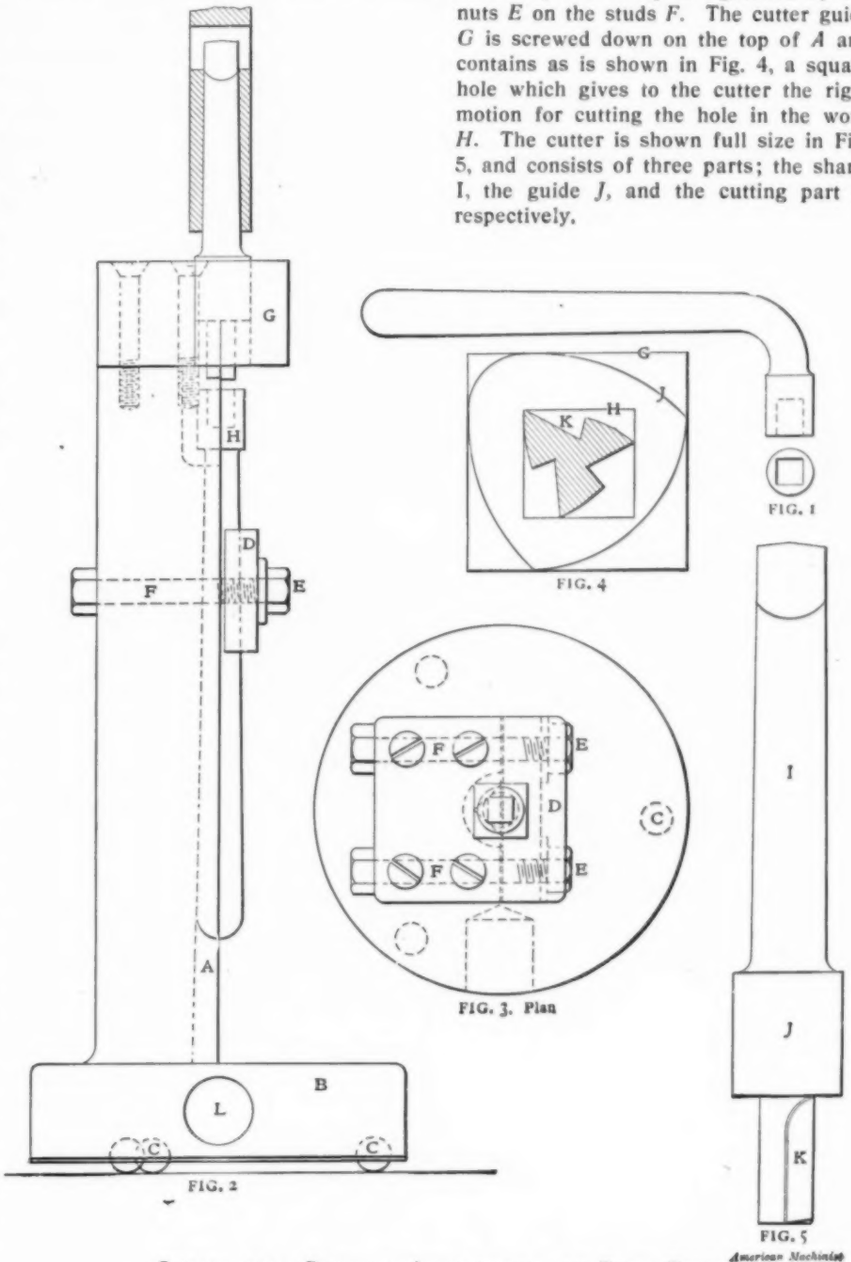
Another thing which we did with this hob was to make the depth of the hob tooth 0.183 inch instead of the standard 0.180. The wheels were turned to the exact size in the throat and the hob sunk in to the standard depth. This prevented the hob from cutting in the roots of its teeth, and the cutting pressure was in consequence considerably less. The reason we did this was that we observed that the breakage of the first hob had taken place, just as the roots of the hob teeth were beginning to cut in the throat of the worm wheel. It may be argued that this method is extremely inaccurate, but it suited the purpose, and is more accurate and quicker in every way than the often-employed practice of gashing the worm wheels by means of an ordinary cutter set at an angle.

Manchester, England. S. T. PARKS.

A Cheap Square Hole Drilling Attachment for the Drill Press

Having a large quantity of chuck and other wrenches to make with a square hole as shown in the accompanying sketch, Fig. 1, the attachment herewith described was constructed to enable them to be turned out more quickly than was possible under previous methods of manufacture. Square-hole drilling still seems to be regarded by a good many persons as a phenomenal feat, but anyone who has seen the operation performed, can easily testify to its feasibility. In the present case it is no more difficult than drilling a round hole, except, of course, that a slightly slower feed is necessary.

The attachment consists of a cast-iron body which is made up of a V-block *A* used for holding the work, on a base *B* which has let into its under side three hardened-steel balls *c* capable of rotation and held in place by a piece of thin sheet steel. The work is held in position as shown by the clamp *D* tightened by the nuts *E* on the studs *F*. The cutter guide *G* is screwed down on the top of *A* and contains as is shown in Fig. 4, a square hole which gives to the cutter the right motion for cutting the hole in the work *H*. The cutter is shown full size in Fig. 5, and consists of three parts; the shank I, the guide *J*, and the cutting part *K* respectively.



SQUARE-HOLE DRILLING ATTACHMENT FOR DRILL PRESS

The cutting action of the cutter will be better understood by referring to Fig. 4 which is shown large and gives the respective positions of the guide *G*, the cutter and the work while working. *G* being fixed, and the cutter rotating,

causes the cutting edge to follow a path parallel with the sides of the square hole in the guide *G* and enter successively the corners of the work in hand, at which instant it acts as though it were pivoted about itself and thus fetches the corner out clean.

Naturally the same principle may be used for cutting hexagonal holes and the leaving of a small fillet in the corner of the hole, where not objectionable, greatly facilitates the cutting. In working the operator prevents the attachment from turning by placing a rod in a hole *L* in the base, thus allowing it enough free side motion, and feeds in the cutter with the right hand.

Waynesboro, Penn. W. W. G.

Makeshift Repair on a Broken End Mill

When using an end mill, if the cutting end becomes broken and the mill cannot at once be replaced, very fair results may be had by grinding the broken end away at an angle leaving the end of the cutter, even though all the end teeth are gone, not square, but at an angle of about five degrees.

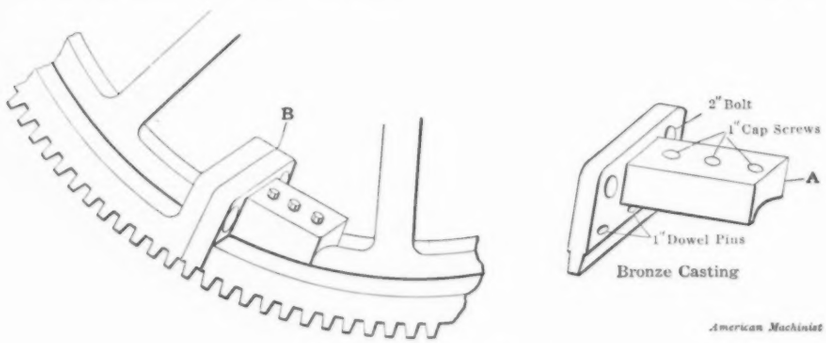
Newport, R. I. FRANK ROSE.

A Repair of a Broken Gear

Some time ago, during one of our extremely busy seasons, we had quite a serious breakdown on one of our largest machines. A tooth and the bolt flange had broken away from one side of an 8-foot cast-iron split gear.

The foundry would not promise anything under a month; and they were not at all sure of even that.

We finally decided to make an exact pattern of the broken piece with a tongue to fit the rib on the under side of the gear rim and to make a bronze casting of it.



THE BREAK AND THE REPAIR

So we brought the broken half of the gear down to the machine room, set it up on our largest planer (which is 22x22 inches by the way), planed off the rough, broken part of the rim on a line with the center of the gear, radially, made the casting from scrap bronze and in three days we were again running the machine.

How long this would have lasted is hard to tell, but at the end of three months when our rush was over and we took the gear out, it seemed as good as when put in.

The cut is self-explanatory; *A* is the bronze casting and *B* is the gear with the casting fitted in place.

Waterville, Conn. EMERGENCY.

A Wire Straightener

It is often necessary to straighten wire which comes in rolls before it is bent or formed. A method much used is to feed the wire between rolls.

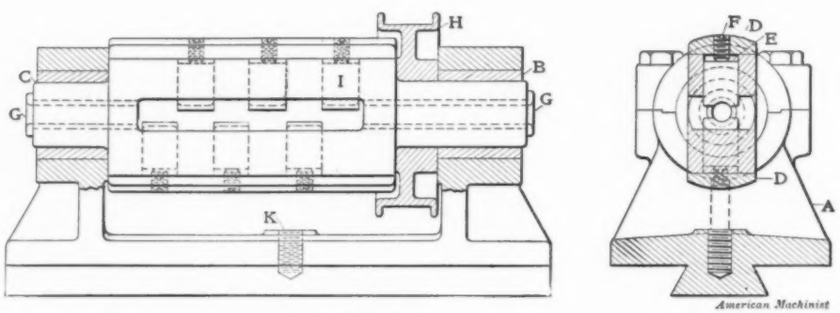
While this method is fair, it is not always convenient to have such a straightener on a machine and it is generally necessary to rely upon the feeding device to pull the wire through the straightener.

By far the best method I know is the one shown in the cut. The device is as a general rule placed either on the back of a machine or on a bracket extending from the frame.

A is the frame or head which fits in a slot in the bracket or frame, *B* a bronze bushing in which the spindle *C* rotates. *C* may be made of machinery steel or mild tool steel.

On to spindle *C* is keyed a pulley *H* and forced into the ends are quills *G* of tool steel, hardened and lapped to size. On either side of the spindle are the caps *D*, screwed and doweled in place; these hold the adjusting screws *F*. On each side of the spindle three square holes are broached as shown, in these holes fit, rather snugly, the tool steel blocks *I*, hardened and ground and with one end grooved to suit the size of the wire.

The wire is pushed through between these blocks and the power turned on. On the head is a pad or boss *K* into which is screwed a stud with a bronze block. This block fits into a forked lever which moves the head back and forth. On some machines that I have designed the attachment was a part of the wire feed and only moved when the feeding attachment moved but where it is possible to do so it is best to have the straightener move back and forth about 20 or 30 times per minute while the speed of spindle goes from 1000 to 1500 revolutions per minute.



A WIRE STRAIGHTENER

The screws *F* are to take up any wear on the blocks *E* and to adjust the blocks to whatever size of wire is being straightened.

This attachment is not as expensive to build as rolls would be, as it is not essential that the blocks be ground just alike because the screw *F* will take up any variation. While with the rolls each of the several rolls must be ground true and the same diameter, the small blocks

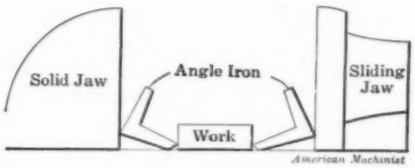
can also be hardened much easier than rolls can be.

The straightness of the wire, which is of as much, if not more, importance than the cost, is by far better.

Bridgeport, Conn. M. WRIGHT.

Gripping Work in the Shaper

On page 1028, Volume 32, Part 2, Dixie shows an excellent device for gripping work in the shaper vise, but the accompanying cut shows a rig that we use in



GRIPPING WORK IN THE SHAPER

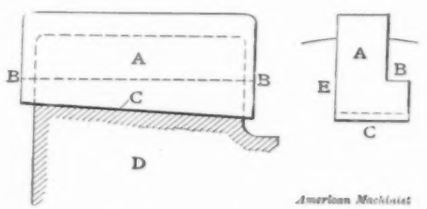
our repair shop, which is much easier to make and just as effective.

The angle irons are merely case-hardened and set in position as shown. The swiveling of the sliding jaw takes care of any taper in the work.

Tropico, Cal. E. M. DAVIDS.

Suggestion for an Expanding Reamer

The accompanying illustration gives an idea for an expanding reamer or boring head which is new, so far as I am aware. It consists of the body *D* which is planed to receive the cutter *A*, the manner of holding this being different from any I have seen. The bottom of the slot *B* is planed at a slight incline, the side *E* is perfectly straight, but the other side is undercut as at *B*. The upper surface of this undercut is, however, parallel with the axis of the reamer or boring bar, and consequently at an angle with



PLAN FOR HOLDING REAMER BLADES

the bottom of the slot. The cutter *A* is planed to match, and is held firmly in place by the wedging action due to the angularity between the two surfaces *B* and *C*. Setting out the cutter, it is only necessary to grind a little from the bottom *C* on a surface grinder or elsewhere, and this allows the whole cutter to be driven forward, and, of course, increases its diameter. After all the cutters had been set out, they would be ground to size in the usual way.

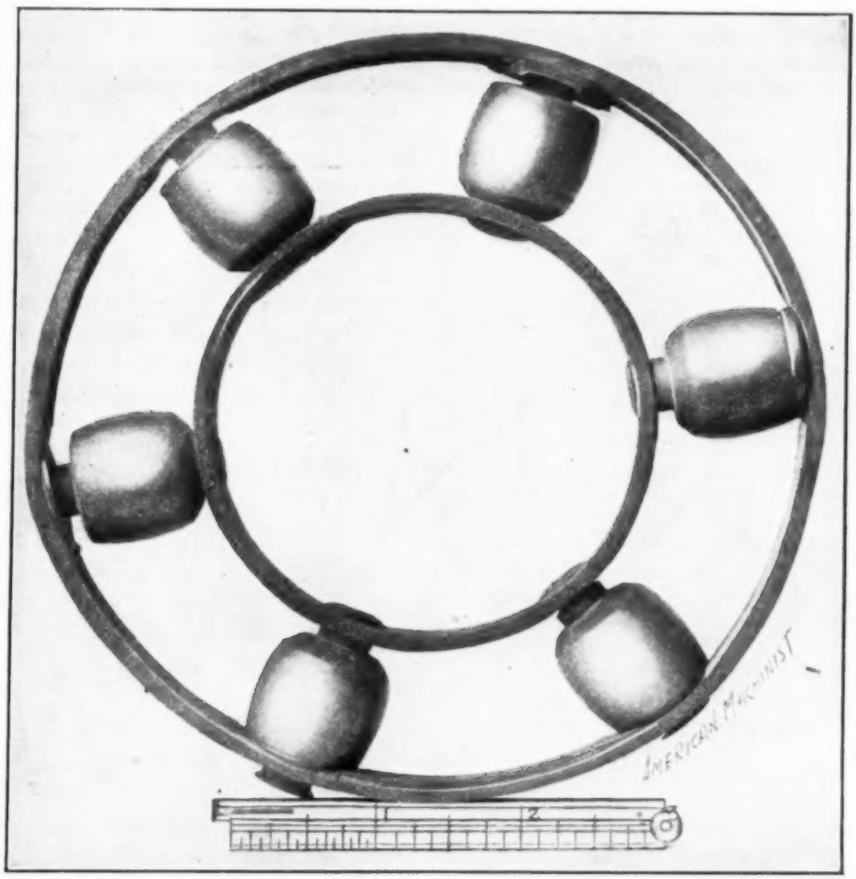
I do not believe there would be any difficulty of the cutters working loose from the string of the cut, but if so the angle *C* could be inclined the other way so as to avoid this.

Fall River, Mass. E. D. H.

An Old Ball Bearing

In repainting the steeple of "Old Trinity" Lutheran church of this city (Lancaster, Penn.) it was necessary to remove the weather vane and ornamental ball for regilding. Having heard of the ball bearing under the vane as being very old I looked the matter up to find the records and such other information as might be of interest. The church building itself was erected of brick shipped from England in 1761 and was dedicated May 4, 1766, while the tower and steeple were not built until 20 years later, in 1794, at which time the vane was put up. The bearing has thus been in use for 115 years, the balls in this time having become worn sufficiently to allow the edges of the washers to touch the ball race. It was thought best to duplicate it as nearly as possible, and a new one was made and put in place.

The vane is 8 feet 11¼ inches long and weighs 150 pounds. There never has been any lubricant of any kind used on the bearing, and the pins through the balls fit more perfectly than it was deemed advisable to make the new ones. The races or thrust plates are made of bronze and show very little signs of wear and were not replaced. The balls were also of bronze and the pins were ⅜-inch brass rod. The rings are of copper ⅛x21/32 inch. The total diameter is 5½ inches. The balls were originally about 1 3/16 inches diameter but 115 years of following the vagaries of the wind has worn them to the shape shown in the



AN OLD BALL BEARING

halftone. The washers at the outer ends of the balls were evidently inserted as a repair at some time.

Possibly other bearings of this type were in use at this early date but I have not been able to locate any.

I cannot get any authentic record of the maker. Some attribute it to the elder Leman of rifle fame, and some to his pupil, Robert Fulton; others say as positively that it was made by Getz, who engraved the first Washington penny and the great seal of the United States; but the church records do not say and the others are legendary.

Lancaster, Penn. E. F. CREAGER.

? DISCUSSION of the PREVIOUS QUESTION ?

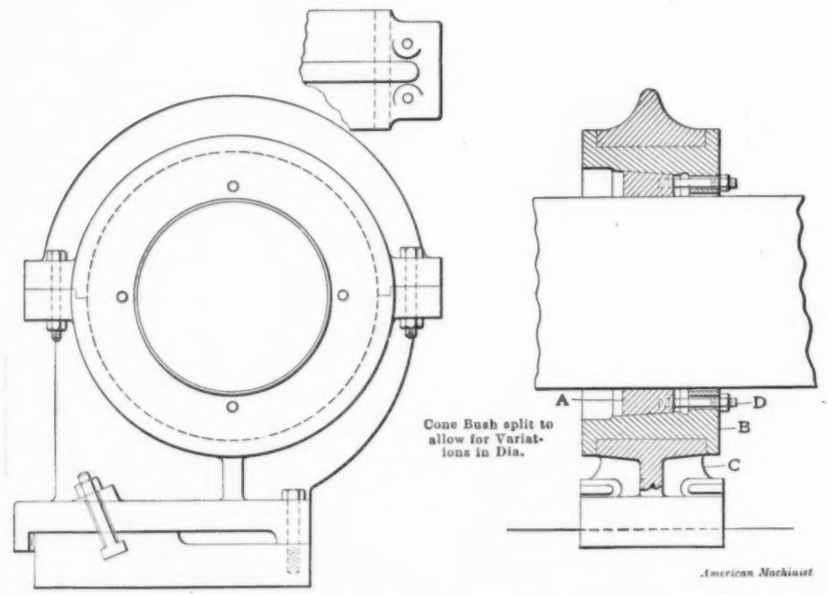
Letters from our Readers showing how many Men of many Minds look upon Various Subjects Opened up in previous Numbers

Examples in Modern Grinding Practice—Long Work on the Grinder—Wheel Truing Device

After reading Mr. Darbyshire's article at page 728, Volume 32, Part 2, I thought a description of a method of grinding large rods would be of interest to many readers, particularly to those who have grinding work larger than the capacity of their machines. It is against the recognized principles of grinding on fixed centers, but nevertheless has proved successful and enabled us to grind work far beyond the capacity of our machine.

Some nine months ago our firm decided to buy a plain grinder to relieve the universal grinder of many of its small jobs. We sent out for quotations for a 10x20-inch machine. An operator from one of the firms asked to quote, called on us, and pointed out that we had work that would warrant a much larger machine. One of these jobs was piston rods, the largest of which was 8¼ inches in diameter and 15 feet long, with a flange at one end 21 inches in diameter and 2 inches thick. As these formed only an occasional job the price of a machine to take them was out of the question with us. The operator then suggested in an offhand manner that we run this particular job in a steady and let it overhang.

At first we did not give the idea serious consideration, but afterward we decided to give it a trial. We, therefore, bought a 16x96-inch Landis machine and when it arrived we designed a steady as shown in the sketch. A separate conical bush *A* is required for each size of rod. The cone is slipped on to the rod and located so as to leave the full capacity of the machine for grinding. The bearing *B* is now slipped on to cone *A*, the outside of this bearing being ground, also the bore of the steady that the bearing revolves in. The cone *A* which is split through one side and partly sawed through at the other, is now drawn up by the four nuts on studs *D*, thus tightening the conical bushing on the shaft, also in the bearing, making the whole rigid. The rod is now put in the machine and fastened to the faceplate; the steady *C* also being secured to the machine by bolts as shown. The portion of the rod between the faceplate and steady is then ground. It is then turned around end for end, the steady fastened on the ground portion and the remainder finished.



STEADY REST FOR LONG WORK IN THE GRINDING MACHINE

The first rod we handled by this method took five hours to grind; the second and third about three and one-half hours each. The work speed with this Siemens-Marten steel rod was 15 feet per minute, the travel of wheel 1¾ inches per revolution of work, and 0.04 inch was left on for grinding. We have ground several since and the results are entirely satisfactory.

Mr. Darbyshire gives two hours ten minutes as the time he required for grinding four car axles. Since we have had this machine we have been asked by a firm of large wagon builders near here to allow them the use of our machine to test the time of grinding a pair of axles. The manager informed us that these axles are roughed out in six minutes, and finished by rolling which gives a good hard wearing surface. There was 0.05 inch left on and there were two different radii in the journal, the outer 3/16 and the inner ⅜ inch. There was also a ⅝ radius at dust-proof seating. The axles averaged fifty minutes each, which we considered very good owing to the different radii. We used the same work speed, 15 feet, but only 1 inch per revolution of work on account of the short distance, with a distinct tarry at the end of each stroke. The wheel used was a 24M.

GEORGE HEY.

Nottingham, England.

Mr. Darbyshire in his article on this subject, at page 728, Volume 32, Part 2, I think could have been a little more explicit. If A's estimate for grinding the gun was two hours, B's 2½ hours, and Norton's 45 minutes, what are his reasons for this variation? Do A and B have machines that cannot produce the goods? A and B must certainly have been "off" in their estimates, as it is impossible for a machine tool of any prominence to produce 200 per cent. more than its competitor. A and B did not submit an intelligent estimate; there was certainly a misunderstanding regarding the amount of metal to be removed or accuracy required.

I notice Mr. Darbyshire on some occasions glazes the wheel with a pebble, to obtain a high polish. I cannot say I have ever found this necessary; when I am grinding a piece of steel which will not take a high finish by ordinary methods I use a dull diamond when truing the wheel, and when using pump for the water supply I generally use 1 ounce of lard oil and 1 ounce of sal soda to 1 gallon of water. But when a high polish is desired I double the quantity of both soda and oil; this seems to give the required results in grinding steel of a fibrous nature.

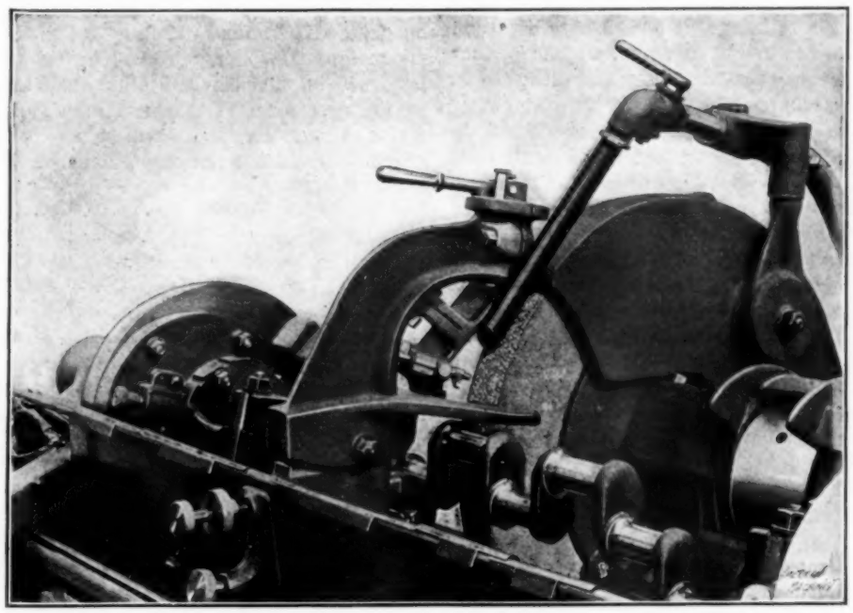
Referring to the wheel-truing device used by Mr. Darbyshire on car axles,

I do not see how he gets a positive movement of 90 degrees when truing the corners of the wheel for the fillets, and his method of getting the different radii would seem rather troublesome, as it would necessitate so many different size plugs.

The combination grinding wheel-truing device manufactured by the Landis Tool Company for truing the face of the wheel and also for forming corners to an exact radius for grinding fillets, is illustrated by the halftone as used on their crank-grinding machines; it has positive stops for the swiveling arm-operating lever, making it impossible to move the diamond past the point it is to go, and is also provided with a graduated gage for setting the diamond to the required radius. The bushing which holds the diamond-holder rod is made eccentric, making it possible to have the cutting point of the diamond always on the center; this being kept in position by a graduation located on the shoe which is used in connection with the setting of the diamond for the different radii. When truing the wheel the method of procedure is as follows: Clamp the device to the top of the rest which is used to support the crank when grinding pins or line bearings, and which is directly in front of the wheel, it only being necessary to move the wheel back from its working position about ½ inch, the swiveling arm-operating lever being brought to its outward or central position, and the stop pins inserted in holes on each side of the lever, making it impossible for it to be moved in either direction, the face of the wheel is trued. One pin is lifted out and placed in the back hole, allowing a movement of 90 degrees, no more, no less. The swiveling arm is then moved back and forth from pin to pin, the wheel being gradually moved up by hand, using the slow-speed mechanism until the diamond touches the side of the wheel. The radius then is correctly formed, the lever being brought back to its central position and the stop pin placed again in the outward hole; the wheel is moved by the diamond for truing the opposite corner, it not being necessary to move the wheel in or out when the radius is formed. This device is used in the same way for both corners of the wheel, and when not in use is easily lifted from the machine and placed to one side where it is kept free from water and dirt during the grinding operation.

J. H. HOLLINGER.

Waynesboro, Penn.

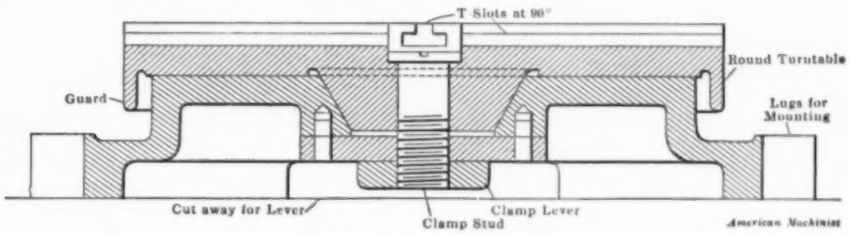


COMBINATION WHEEL-TRUING AND CORNER-ROUNDING DEVICE FOR LANDIS GRINDER

A Milling Machine Turret

I notice at page 998, Volume 32, Part 2, drawings, photographs, and description of an indexing milling fixture, and I am taking the liberty of making a slight criticism of this device, and present a sketch, showing a construction which I have used at different times on indexing fixtures of this character, both manually and automatically operated, which has given excellent results.

The criticism I wish to make concerns the central pivot stud, which not only serves as a clamping stud, but also as a center of rotation, and consequently a means of alinement for the entire turn-table, and any wear which may develop at this point will naturally affect the accuracy of the entire device.



A MILLING-MACHINE TURRET

The accompanying sketch shows the turn-table supported on a large circular flat bearing surface, which takes the downward thrust, and it is also provided with a tapered central bearing of large size, which owing to its conical form, will continue to centralize the turn-table no matter how much wear there may be on the fixture. This projection is cast integrally with the turn-table, and may also combine the smaller, or clamping stud in the center if so desired. However, it is sometimes advisable to make the clamping stud of a separate piece, usually of machinery steel, driven through the turn-table from above, and provided with a cylindrical hub at its upper end, and threaded at its lower extremity to receive the clamping-lever hub. As there will naturally be a great deal of wear on these threads, which will cause them to be short-lived in comparison with the rest of the fixture, it is desirable to be able to replace this piece easily, and by using this construction, it is obvious that this may be readily accomplished.

I have also found it good policy to provide the turn-table with a guard, extending some distance below the supporting surface of the base, in order to prevent the chips from the cutter getting into the bearing surfaces, which they will always do if the bearing joint is exposed. This does not interfere with the cutting of index graduations on the turn-table, as the pointer may be screwed to the base, and may reach up in front of the turn-table edge and serve as an index pointer.

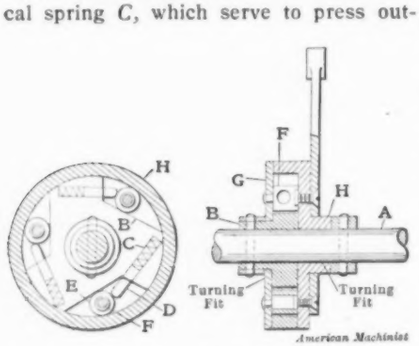
It is always desirable to locate the index plunger as far from the pivot as possible, in order that any inaccuracy of indexing or of the fit of the plunger in its bushing may have as little angular effect on the alinement of the work as possible. The index plunger and the operating device are similar to those shown in the article referred to.

The turn-table may be either round or square, and provided with parallel T-slots, or with diametrical cross-slots, according to the requirements of the device.

Cleveland, Ohio. C. NOSRAC.

Device Serving as a Silent Pawl

In the illustration *A* represents the driven shaft carrying upon it the tool-steel cam block *B*, which is securely mounted to it by means of a key or taper pin through its hub. It will be noticed that this block has three notches in its circumference, 120 degrees apart, and that the radial surface of each of these notches is drilled to receive a small helical spring *C*, which serve to press outwardly a hardened steel plunger pin *D*. These pins bear against the hardened steel rollers *E*, which are loosely mounted on the shouldered studs *F*, riveted to a circular disk or plate *G*, which is allowed to turn upon the hub of the cam block *B*.



DEVICE SERVING AS A SILENT PAWL

A hardened-steel shell *H* is mounted on the shaft *A* in such manner that it is free to rotate or rock as desired. In the illustration it is shown with a rocking lever attached to it, so as to impart an intermittent motion to the driven shaft *A*.

The rotation of the clutch shell *H* in the direction in which the plungers *D* push will cause the rollers to become securely wedged between the edge of the shell and the cam block *B*, thus imparting positive rotation to the driven shaft *A*, but upon reversing the motion of the clutch shell it will be seen that the rollers will automatically release and permit of perfectly free motion of the shell on the recovery stroke.

Should the friction of the mechanism being driven be insufficient to prevent back lash of the shaft *A*, a duplication of this device may be mounted on the shaft, the only difference being that the shell in this case, while not being secured to the shaft in any way, is rigidly fastened to the frame of the machine, so that it cannot rock or rotate in either direction. One clutch will then drive the shaft ahead and the other will prevent its back lashing, due to the plungers keeping the rollers permanently pressed into locking position. The grip of this device is instantaneous, and if well made it will show no appreciable lost motion.

Dayton, Ohio. C. NORSMAN.

Brazing Cast Iron

George Tyro's article, on page 1131, Volume 32, Part 2, interests me, as within the past month I went into the shop of one of these fellows who makes a specialty of brazing cast iron. He has a secret process and was both shocked and grieved when I asked him what the secret was. I further hurt his feelings by telling him that I doubted that his secret process was worth anything, or was any better than the way we used to do the job with common yellow brass and borax or boric acid. By the way, that "Fluxene" which Mr. Tyro mentions, was powdered boric acid.

My mention that I could braze cast iron with the same materials used for wrought iron tempted the expert to bet me I couldn't do it.

The piece selected was a small bracket. I cleaned the surfaces of the break, removing all dirt and grease. A good way to do this if you have much cast-iron brazing to do is to have some caustic soda in solution and commercial muriatic acid handy, washing the break first with the soda and then rinsing off in clean water and then with the acid and again rinsing off in clean water. The parts are then securely pinned or clamped together so that they will not shift. Gas, or any good, clean flame or fire of any sort will do. Charcoal is good fuel. Heat the job slowly and thoroughly. As the piece becomes hot apply the borax or boric acid and don't be afraid that you will use too much. Keep the job at a good red heat for several minutes with plenty of flux flowing over and into the crack. Then apply the spelter or common yellow brass and plenty of it, either in wire or granular form, together with more flux. Let the job "soak" in the heat applying plenty of brass and flux. Cool it off slowly. The principal advantage about using boric acid is that it does not form as hard a "glass" scale on the work and is consequently less hard on the files used to clean the braze. After the job is cool it can be dipped for a few minutes in boiling water, which seems to loosen the scale. When brazing with borax or boric acid another way to loosen the scale is to brush the joint with a stiff steel brush while the job is still red hot. I made the braze on the bracket in this way to the surprise of the expert.

Two or three years ago I had an experience with one of these cast-iron brazing concerns. I had been after the boss of the concern for some time to make a demonstration. At last he notified me to be on hand the next morning at a big marine repair shop. The job was a propeller blade. A piece about 2 feet long had been broken from the tip.

The job was an important one, as upon its success depended a contract to repair all the broken propeller blades of a large tramp steamship company. I may mention that it is a matter of common occurrence for propeller blades to break a little way from the tip, owing, it is said, to "cavitation."

The superintendent of the line was there and the brazed blade. The boss of the brazing company occupied our attention by telling us what a fine job it was and how much stronger the brass braze was than the cast iron on each side of it. Eventually the blade was laid on two iron bars about 2 feet apart under the steam hammer. Another bar was placed just over the joint and one very mild lick with the hammer broke the blade through the old break. The job had been very poorly done, the brass showing like swiss cheese, only more so, simply a series of air bubbles covered with brass and joining each other.

The boss brazer in a sad voice asked me if I was going to write up the test for the AMERICAN MACHINIST, and seemed greatly relieved when I told him no. Later on he got confidential and told me that he had brazed castings which had "shaken apart" while on the wagon being delivered after the repair had been made.

Personally, where there is any strain a few plate patches properly applied, I think, are much safer than a brazed joint in cast iron.

New York. E. A. DIXIE.

The Toggle Joint

Having read Mr. Terhune's article on page 857, Volume 32, Part 2, I think my method of solving toggle-joint problems will interest him and other readers. In the first place, I dispense with formulas altogether, and invariably work graphically, as it is not only quicker, and in that way more satisfactory, but it has the advantage of being simple to comprehend; and, as I hold that working with formula of which the true meaning is but hazily impressed upon one's mind is bad practice whenever simpler methods are available, and is liable to lead one into unperceived errors, I think graphic and other straightforward methods should be adopted whenever possible.

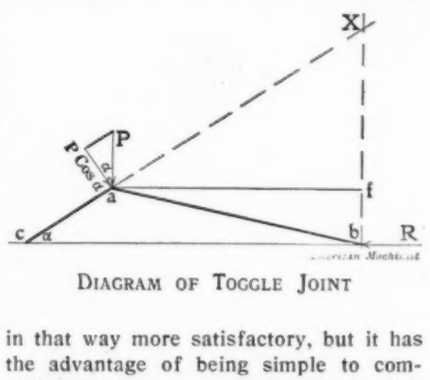


DIAGRAM OF TOGGLE JOINT

Considering the toggle in the figure, it is required to know what the resistance

R is when the force P is acting as shown and is known. The first part of the process is to sketch a diagram of tne toggle and the following reasoning is simple, sound and easy to remember.

Take the bar $a\,b$. The end a is constrained to move in an arc of radius $c\,a$, about the center c, and the end b is constrained to move in the straight line $c\,b$. By the law of virtual or instantaneous centers of motion, at the *instant* the bar is in the position shown there is a center about which every point in it is moving. This center is not fixed for all positions of the bar—on the contrary it is constantly varying—but it is always fixed for the same position. In this case it is obvious that at this instant the end a is moving at a tangent to the arc of center c and, therefore, its virtual center lies somewhere on the line $c\,a$ extended. And, likewise, the end b is moving in the line $c\,b$ which is tangent to the arc of a circle drawn from the virtual center, and, therefore, the virtual center lies somewhere on a line drawn at b perpendicular to $c\,b$. Then this virtual center is bound to be at X where the virtual radii meet.

From this we see plainly that, considering the forces as acting on a lever, $P\,a\,f$ equals $R\,b\,X$, for $P\,a\,f$ is the same as $P\ cos.\ \alpha\ a\,X$.

This reasoning takes up a good deal of room, but it is simple and easy to remember, while the actual working out of any particular case is quick and sure, all that is necessary being to extend $c\,a$ to meet the perpendicular from b; measure $a\,f$ and $b\,X$ in any convenient units and $R\,b\,X = P\,a\,f$, and, P being known, R is readily found.

Sheffield, England. CONAM.

Strengthening a Press Beam

On page 1098, Volume 32, Part 2, appears an article headed "How can this Press Beam be Strengthened?" showing by a sketch how the beam had broken, and by another the proposed method of strengthening the beam. That the proposed method of strengthening would be practically useless will be seen by referring to Fig. 1 herewith and noting the location of the breaks, which in both cases come almost entirely within the space spanned by the proposed truss, and so consequently do not strengthen the beam as intended; the slight gain in the strength of the beam being due to the slightly lessened distance of length of the beam which lies between the ends of the truss where they are joined to the beam, as at first constructed.

Referring again to Fig. 1, it appears to me that the iron in the beam is proportioned about right in the original, as the break occurred once, part way between the end and the boss, and once at the boss itself, but that the beam was not made strong enough at first to stand the strain placed upon it. The proposed method strikes me as unmechanical in appearance and it seems to me it would be inconvenient, being in the way of the operator.

As the depth of the hub or boss cannot be changed, I would suggest, without going into mathematics, that it be enlarged in diameter about 30 per cent., or ⅓, so as to prevent a break again at

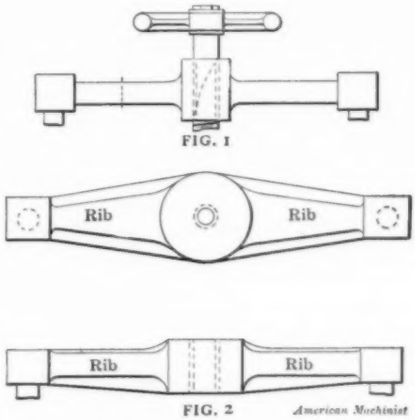


FIG. 1

FIG. 2 American Machinist

SUGGESTION TO STRENGTHEN A PRESS BEAM

that point, and then to increase the strength of the beam between the hub and the ends I would place heavy ribs with good sized fillets as shown in Fig. 2 with the corners well rounded at all places. This I think will furnish the requisite strength and at the same time look neat and in keeping with the rest of the press. E. S. WILLIAMS.

Bridgeport, Conn.

In reply to the question propounded by C. L. S. at page 1098, Volume 32, Part 2, the construction proposed by Smith for strengthening the press beam is wrong in principle, although if the joints where the top beam bolts to the lower one were firmly pulled together by good liberal sized bolts it would add to the strength because the lower beam would then be partially restrained. This restraining action would be still more pronounced if the part were one casting, as shown in Fig. 3 of the original, but the exact amount of this strengthening effect is rather doubtful and if he wishes to follow this construction he should take advantage of all the opportunity afforded for transferring as much of the bending into the upper beam as possible by making it more like Fig. 4; this is, however, an abnormal construction.

Jones is correct in stating that the depth of the beam in Fig. 3 of the original question is not the distance between X and Y, but even with the strut he suggests it would not be a beam of this depth but rather two shallow beams, each carrying part of the load, the lower beam being somewhat restrained by the upper one.

In a beam of this sort there is a peculiar action at the hub sometimes overlooked. Fig. 5 shows such a beam with the diameter of the hub exaggerated for purposes of illustration. At the top of the hub there is a pull P on either side tending to elongate it, while at the bottom there is a thrust T on each side trying to collapse the hub. On sections $A\,A$ there is torsion, the amount of which

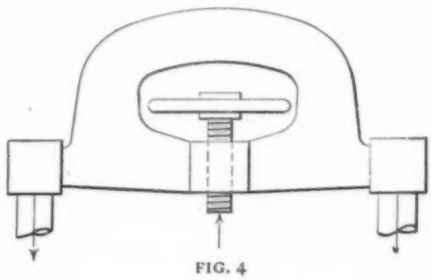


FIG. 4

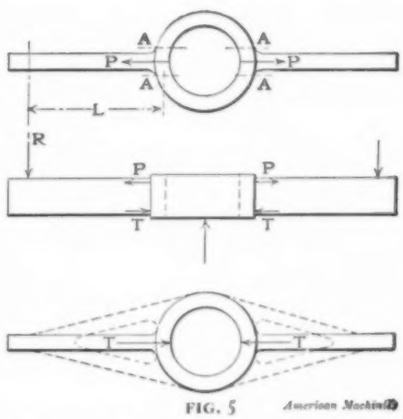


FIG. 5 American Machinist

SUGGESTION FOR STRENGTHENING A PRESS BEAM

is one half of $R \times L$. To avoid this torsional action make the beam as indicated by the dotted lines in the bottom plan view of Fig. 5.

For the specific conditions stated by C. L. S. it seems that the only two reasonable solutions of his problem are either to make the hub larger in diameter and increase the breadth of the beam, or else make it of stronger material, a steel casting or forging if the present one is of cast iron.

Philadelphia, Penn. JOHN S. MYERS.

A progressive use of vanadium steel is recorded in the construction of six Mallet compound engines with vanadium cast-steel frames throughout. The frames averaged 8000 pounds in weight, and contain about 0.18 per cent. vanadium; they averaged 80,975 pounds per square inch in tensile strength, elastic limit, 45,024 pounds. A complete engine will weigh 414,000 pounds and cost about $20,000.

Packing Machinery for Export

By A. J. Wolfe

The matter of packing for export has for a long time been marked by vehemence of language on the part of consignees and almost frivolous indifference on the part of consignors. American manufacturers have come in for a great deal of abuse in this connection, and it must be admitted that some of it has been richly deserved. However, for some time past there has been a noticeable effort to improve upon packing methods, and manufacturers realize that it is not only important to secure an order, but also to fill it properly and in such a manner that a continuance of the business may ensue.

Follow Instructions

It is important in the first instance to follow instructions as to packing, if specific instructions are given. Under no circumstances should the exporter place his own ideas above the specific instructions of the customer. Ridiculous as these may seem to a packer who is accustomed to ship goods to Illinois or Connecticut, their oddity is doubtlessly due to local conditions with which the packer is not acquainted.

When an importer in Colombia demands that boxes be covered with tarpaulin or burlap, and that the covers be *sewed*, he will frequently caution the shipper not to drive nails through the outside. Inexperienced shippers feel tempted to disregard the injunction and drive nails through the cover and case to strengthen the latter. In the moist heat of Colombia the nails invariably rust, rot the cover, and it is gone long before the case reaches its destination. The importance of trusting the judgment of the customer in following instructions cannot be overestimated. There are peculiarities of customs requirements, of tariff classifications, etc., that are well known to the consignee, but may be unknown to the shipper.

Three Things to Consider

The proper packing of an order for export shipment may be considered under three heads: The proper assembling and checking of the articles ready to be packed, the proper receptacle and the correct marking of the latter.

It is absolutely necessary to exercise great care in checking the contents of each case. In some countries the rates of duty vary with the composition of the articles in such a manner that the presence of certain rubber accessories, brass parts, nickel-plated parts or porcelain parts may mean excessive rates of customs duties on the whole shipment. Follow the instructions of the customer. Before placing any unasked-for articles, such as catalogs, advertising matter, souvenirs, etc., into the case, make sure that it would create no complications in the country to which the shipment is destined. Many countries impose heavy fines if it is discovered that the shipment contains articles not mentioned on the consular invoice, even if they be of no value; others impose duties on advertising matter and souvenirs.

It is necessary to furnish on the invoice an absolutely correct record of the contents of each package. The weights and the quantity of all articles should be given. It is important to give correct weights. In this connection it may be stated that gross weight is the weight of the entire case, net weight is the weight of the article in the original package. In Mexico, however, the net weight is the weight of the article without any wrappings, and legal weight includes also the immediate wrapping. All weights must be stated correctly on the consular invoices, generally in the metric system, excepting for Russia, England, Canada, Australia, South Africa, etc.

The Actual Packing

Now with regard to the actual packing. The shipper must consider that the machine has to pass a journey by rail, reloading, a journey by sea, loading and reloading, customs examination, then another journey perhaps or storage. Packing was described by someone as a series of operations intended to preserve the machine in good order from the moment it leaves the factory till it reaches the consignee.

Machines should be completely assembled, inspected, tested and dismounted to such an extent as to insure safety. No part of the machine should be in contact with the sides of the case that is not capable of standing the handling to which the case is subjected. The feet of a lathe bed can be broken by the packing case falling on one of its corners.

Fragile projecting parts should be packed in separate boxes and be protected against rough handling during unpacking. Screw threads should be wrapped with rags, all openings through which dirt could enter plugged up with wood. All pieces should be labeled or tagged with indications of their position on the machine and a detailed list of parts as well as a cut should accompany the machine. This is very important, because the machines are liable to be unknown or insufficiently known to the consignee's workingmen. This cut, in lieu of which a drawing should be supplied, also will permit the custom-house inspectors to convince themselves that the detached pieces actually form part of the machine; otherwise these pieces may have to pay duties at a higher rate than the machine itself. If the machine has been taken apart and made up into several packages, a cut or drawing should be placed in *each* case, as in general all of the packages are not opened in the custom houses.

The finished and polished parts should be protected against rust by a coating, which must remain intact after the machine is packed. Polished surfaces in contact with each other need be only lubricated with oil. The coating should not be applied to finished parts which are altogether protected from outside contact. A good coating is perfectly acid-free vaseline, or solidified oil.

Economize Space

Machinery for export should be packed in the least possible cubic space. Ocean freights are seldom figured on weight, but mostly on space. The charges are so much per ton of 2240 pounds, or 40 cubic feet. This makes 56 pounds per cubic foot. Every effort should be made to reduce the volume of the cases by dismounting projecting parts. It must not be forgotten at the same time that where packages weigh more than two tons extra charges for loading and reloading are made, and the costs increase considerably.

In some countries, as Colombia, it is necessary to pack the machine in small sections for transport on mule back. A mule can carry about 250 pounds, in packages of 125 pounds on each side.

Making the Cases

A French expert recommends the following construction: The bottom of the case should be strong enough to carry the total weight of the machine. It should have two longitudinal battens to facilitate balancing on a roller. Transverse planking spiked to the battens forms the bottom of the case. On the bottom, constructed as indicated, two frames should be built around the machine, dividing the length of the case in three parts in such a manner as to support the pressure of ropes or chains when handling with cranes or other hoisting apparatus. These frames will, at the same time, act as supports for the interior braces, and as lateral supports in case the package is laid on its side, which often happens in spite of instructions. Around these principal elements are built the sides, ends and top of the case, which are designed simply for protecting the machine generally.

Cases should be marked with brush or stencil. Some countries demand stencil marks. Chile, for instance, does not permit brush addresses. For some coun-

tries it is necessary to mark two adjacent sides of the cases. For Argentina all four sides must be marked. It is proper to mark only initials of the consignee in connection with a diamond, square, or circle, and the port of destination. Where old cases are used all old marks should be previously carefully removed.

Words like "This side up with care," or "Fragile" are worse than useless. Foreign longshoremen in most countries can't read their own language, far less English, and would not stop to read if they could. In connection with the subject of packing, it may be wise to state how important it is that all documents, including bills of lading, consular invoices, etc., be shipped to the consignee very promptly and never later than with the steamer carrying the goods.

To sum up, the question of packing implies accuracy, care in following instructions and the trouble of providing safe and satisfactory cases. The extra expense should be charged up on the goods or borne by the consignor. It irritates the consignee to find charges for "packing." But proper packing is one of the most important conditions of success in the export trade.

Making Marmon Rear Axles of Pressed Steel

The rear axle of the Marmon car is of pressed steel with bronze ends cast in place. This makes a very light, yet substantial axle and its machinery involves some interesting shop problems. These are solved by the builders, Nordyke & Marmon, Indianapolis, Ind., in a very interesting manner.

The first operation is to enlarge the openings as shown in Fig. 1.

This shows a special fixture for enlarging the openings in the pressed-steel rear-axle housing. These pressings come with 5-inch openings and are cut out to 10¼ inches in this fixture. The piece is set up with the set screw shown at the right-hand end, against locating blocks on the base of the fixture. The clamp ring is then placed as shown. The pilot of the cutter is centered by a hardened bushing located at the bottom of the fixture and the cutter passes through, cutting out both the top and bottom of the pressing. This pressed-steel housing is made in two pieces, autogenous welded along the seams, as shown. When the operation above described is completed the pressing is ready for the foundry where the bronze end pieces, as shown in Fig. 2, are cast on. The boring serves as a gage for the molding-flask fixture.

Fig. 2 shows a special steady rest for turning the bronze ends of these rear-axle

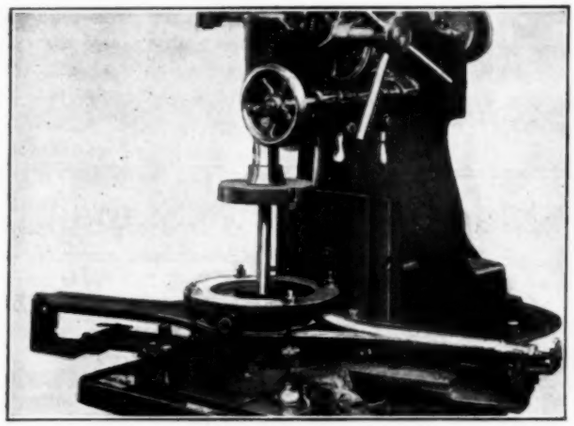


FIG. 1. CUTTING OUT THE CENTER HOLES

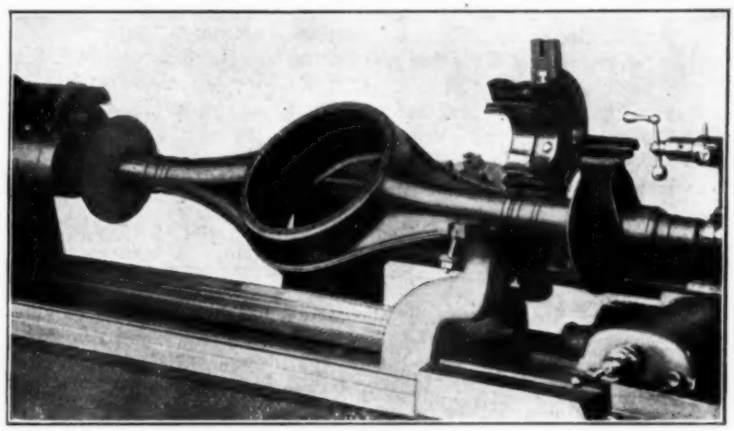


FIG 2. TURNING THE BRONZE BEARINGS CAST ON ENDS

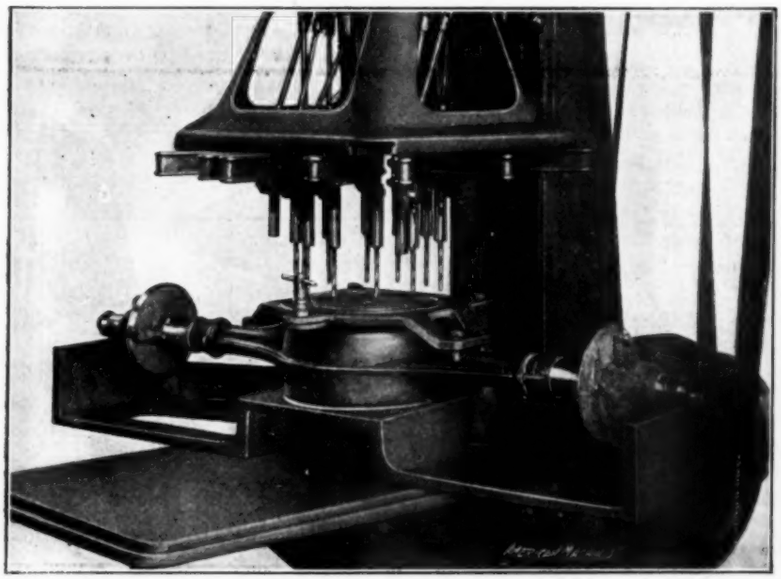


FIG. 3. DRILLING FOR HOUSING COVER

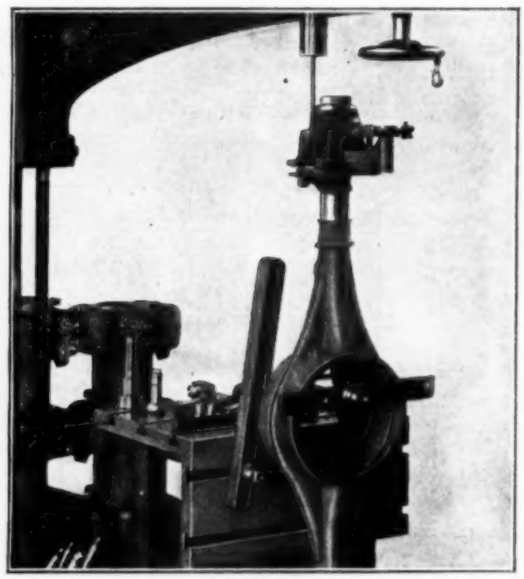


FIG. 4. DRILLING AXLE FLANGE

Packing Machinery for Export

By A. J. Wolfe

The matter of packing for export has for a long time been marked by vehemence of language on the part of consignees and almost frivolous indifference on the part of consignors. American manufacturers have come in for a great deal of abuse in this connection, and it must be admitted that some of it has been richly deserved. However, for some time past there has been a noticeable effort to improve upon packing methods, and manufacturers realize that it is not only important to secure an order, but also to fill it properly and in such a manner that a continuance of the business may ensue.

Follow Instructions

It is important in the first instance to follow instructions as to packing, if specific instructions are given. Under no circumstances should the exporter place his own ideas above the specific instructions of the customer. Ridiculous as these may seem to a packer who is accustomed to ship goods to Illinois or Connecticut, their oddity is doubtlessly due to local conditions with which the packer is not acquainted.

When an importer in Colombia demands that boxes be covered with tarpaulin or burlap, and that the covers be *sewed*, he will frequently caution the shipper not to drive nails through the outside. Inexperienced shippers feel tempted to disregard the injunction and drive nails through the cover and case to strengthen the latter. In the moist heat of Colombia the nails invariably rust, rot the cover, and it is gone long before the case reaches its destination. The importance of trusting the judgment of the customer in following instructions cannot be overestimated. There are peculiarities of customs requirements, of tariff classifications, etc., that are well known to the consignee, but may be unknown to the shipper.

Three Things to Consider

The proper packing of an order for export shipment may be considered under three heads: The proper assembling and checking of the articles ready to be packed, the proper receptacle and the correct marking of the latter.

It is absolutely necessary to exercise great care in checking the contents of each case. In some countries the rates of duty vary with the composition of the articles in such a manner that the presence of certain rubber accessories, brass parts, nickel-plated parts or porcelain parts may mean excessive rates of customs duties on the whole shipment. Follow the instructions of the customer. Before placing any unasked-for articles, such as catalogs, advertising matter, souvenirs, etc., into the case, make sure that it would create no complications in the country to which the shipment is destined. Many countries impose heavy fines if it is discovered that the shipment contains articles not mentioned on the consular invoice, even if they be of no value; others impose duties on advertising matter and souvenirs.

It is necessary to furnish on the invoice an absolutely correct record of the contents of each package. The weights and the quantity of all articles should be given. It is important to give correct weights. In this connection it may be stated that gross weight is the weight of the entire case, net weight is the weight of the article in the original package. In Mexico, however, the net weight is the weight of the article without any wrappings, and legal weight includes also the immediate wrapping. All weights must be stated correctly on the consular invoices, generally in the metric system, excepting for Russia, England, Canada, Australia, South Africa, etc.

The Actual Packing

Now with regard to the actual packing. The shipper must consider that the machine has to pass a journey by rail, reloading, a journey by sea, loading and reloading, customs examination, then another journey perhaps or storage. Packing was described by someone as a series of operations intended to preserve the machine in good order from the moment it leaves the factory till it reaches the consignee.

Machines should be completely assembled, inspected, tested and dismounted to such an extent as to insure safety. No part of the machine should be in contact with the sides of the case that is not capable of standing the handling to which the case is subjected. The feet of a lathe bed can be broken by the packing case falling on one of its corners.

Fragile projecting parts should be packed in separate boxes and be protected against rough handling during unpacking. Screw threads should be wrapped with rags, all openings through which dirt could enter plugged up with wood. All pieces should be labeled or tagged with indications of their position on the machine and a detailed list of parts as well as a cut should accompany the machine. This is very important, because the machines are liable to be unknown or insufficiently known to the consignee's workingmen. This cut, in lieu of which a drawing should be supplied, also will permit the custom-house inspectors to convince themselves that the detached pieces actually form part of the machine; otherwise these pieces may have to pay duties at a higher rate than the machine itself. If the machine has been taken apart and made up into several packages, a cut or drawing should be placed in *each* case, as in general all of the packages are not opened in the custom houses.

The finished and polished parts should be protected against rust by a coating, which must remain intact after the machine is packed. Polished surfaces in contact with each other need be only lubricated with oil. The coating should not be applied to finished parts which are altogether protected from outside contact. A good coating is perfectly acid-free vaseline, or solidified oil.

Economize Space

Machinery for export should be packed in the least possible cubic space. Ocean freights are seldom figured on weight, but mostly on space. The charges are so much per ton of 2240 pounds, or 40 cubic feet. This makes 56 pounds per cubic foot. Every effort should be made to reduce the volume of the cases by dismounting projecting parts. It must not be forgotten at the same time that where packages weigh more than two tons extra charges for loading and reloading are made, and the costs increase considerably.

In some countries, as Colombia, it is necessary to pack the machine in small sections for transport on mule back. A mule can carry about 250 pounds, in packages of 125 pounds on each side.

Making the Cases

A French expert recommends the following construction: The bottom of the case should be strong enough to carry the total weight of the machine. It should have two longitudinal battens to facilitate balancing on a roller. Transverse planking spiked to the battens forms the bottom of the case. On the bottom, constructed as indicated, two frames should be built around the machine, dividing the length of the case in three parts in such a manner as to support the pressure of ropes or chains when handling with cranes or other hoisting apparatus. These frames will, at the same time, act as supports for the interior braces, and as lateral supports in case the package is laid on its side, which often happens in spite of instructions. Around these principal elements are built the sides, ends and top of the case, which are designed simply for protecting the machine generally.

Cases should be marked with brush or stencil. Some countries demand stencil marks. Chile, for instance, does not permit brush addresses. For some coun-

tries it is necessary to mark two adjacent sides of the cases. For Argentina all four sides must be marked. It is proper to mark only initials of the consignee in connection with a diamond, square, or circle, and the port of destination. Where old cases are used all old marks should be previously carefully removed.

Words like "This side up with care," or "Fragile" are worse than useless. Foreign longshoremen in most countries can't read their own language, far less English, and would not stop to read if they could. In connection with the subject of packing, it may be wise to state how important it is that all documents, including bills of lading, consular invoices, etc., be shipped to the consignee very promptly and never later than with the steamer carrying the goods.

To sum up, the question of packing implies accuracy, care in following instructions and the trouble of providing safe and satisfactory cases. The extra expense should be charged up on the goods or borne by the consignor. It irritates the consignee to find charges for "packing." But proper packing is one of the most important conditions of success in the export trade.

Making Marmon Rear Axles of Pressed Steel

The rear axle of the Marmon car is of pressed steel with bronze ends cast in place. This makes a very light, yet substantial axle and its machinery involves some interesting shop problems. These are solved by the builders, Nordyke & Marmon, Indianapolis, Ind., in a very interesting manner.

The first operation is to enlarge the openings as shown in Fig. 1.

This shows a special fixture for enlarging the openings in the pressed-steel rear-axle housing. These pressings come with 5-inch openings and are cut out to 10¾ inches in this fixture. The piece is set up with the set screw shown at the right-hand end, against locating blocks on the base of the fixture. The clamp ring is then placed as shown. The pilot of the cutter is centered by a hardened bushing located at the bottom of the fixture and the cutter passes through, cutting out both the top and bottom of the pressing. This pressed-steel housing is made in two pieces, autogenous welded along the seams, as shown. When the operation above described is completed the pressing is ready for the foundry where the bronze end pieces, as shown in Fig. 2, are cast on. The boring serves as a gage for the molding-flask fixture.

Fig. 2 shows a special steady rest for turning the bronze ends of these rear-axle

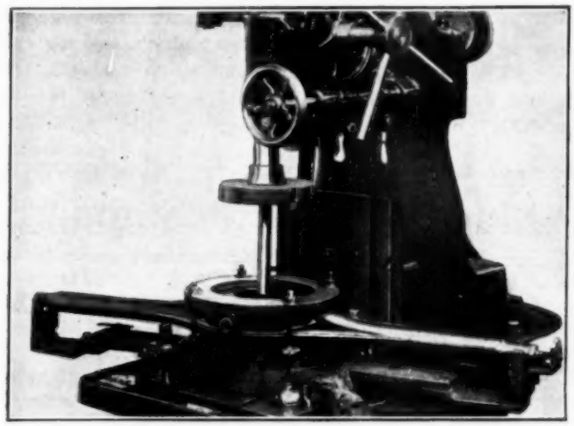


FIG. 1. CUTTING OUT THE CENTER HOLES

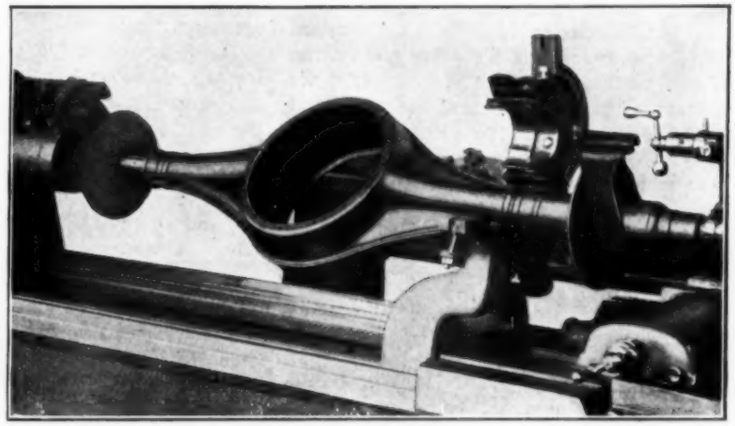


FIG 2. TURNING THE BRONZE BEARINGS CAST ON ENDS

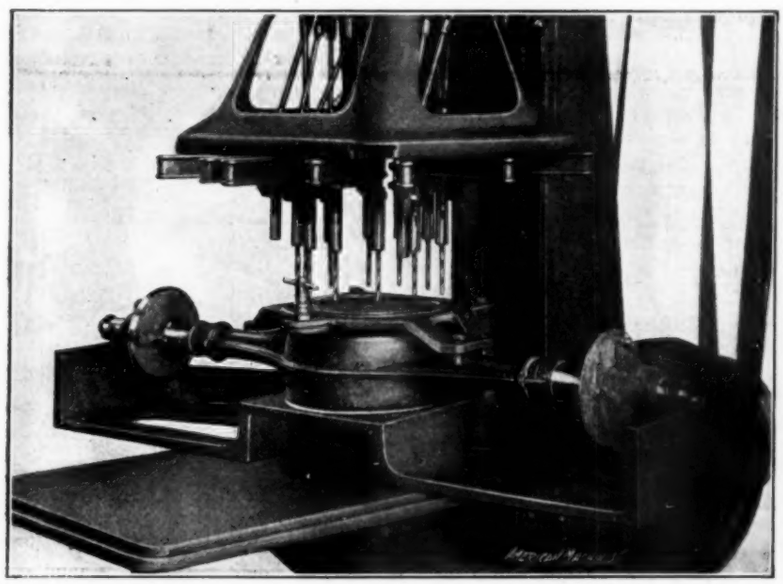


FIG. 3. DRILLING FOR HOUSING COVER

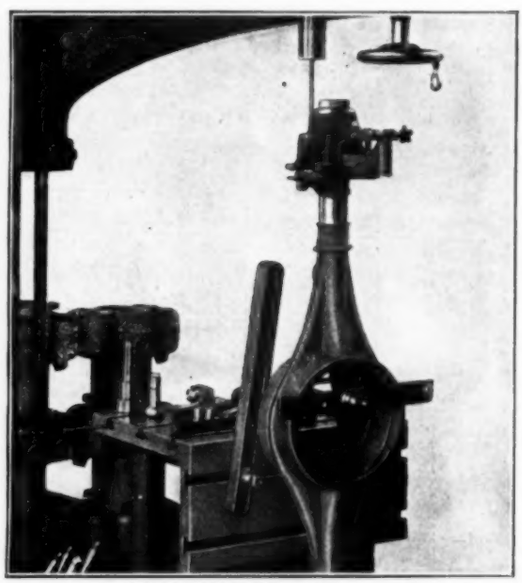
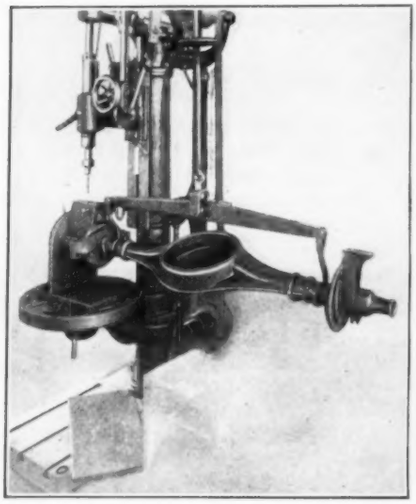
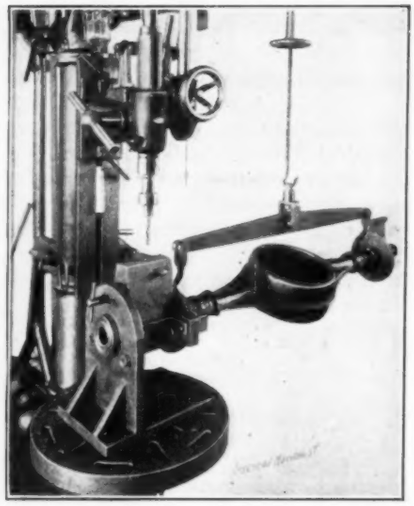


FIG. 4. DRILLING AXLE FLANGE





FIGS. 5 AND 6. SUPPORTING THE AXLE TO DRILL THE ENDS

housings. The piece is first centered by countersinking the ends with special appliances and when it is put in the lathe it is held by pipe center in the tailstock spindle for setting the steady rest. Within the hinged steady rest is a dovetailed split collar forming a bearing and having also an integral collar carrying four set screws used for centering the piece and for securing it to the piece. The split collar revolves with the axle housing in the steady rest. When placing the piece in position and when removing it the split collar is slipped endwise and separated. The driver at the left is a trifle out of the ordinary.

The fixture used for locating and holding the rear-axle housing for drilling is shown in Fig. 3. It is in reality a duplex jig as it carries two locating plates, one under the other, as partially shown in the illustration. The upper plate has 5/16-inch bushings and the lower plate ¼-inch bushings. Thus one fixture is used for drilling both sides of the housing, one side with ¼-inch holes which are afterward tapped for 5/16-inch studs, and the other side with 5/16-inch holes. The advantage of a multiple drill head is shown on such work as this.

The flanges of the end pieces are drilled with the jig shown in Fig. 4, which is arranged to slip over the end of the axle for drilling eight holes at this point. Since this photograph was taken the fixture has been completed by adding a center-locating plate with quick-acting clamps to hold the piece to the face of the radial drill-press table.

An interesting fixture is shown in Fig. 5 for slinging the axle while being operated on in the indexing drill-press fixture shown for locating and drilling five holes. The axle housing is first swung in the single tree as shown. The end is then slipped into the fixture and is secured with a hinged clamp, the piece being located by the finished brake-ring support and finished end. This fixture is universal since it is used for both ends of the axle, which are necessarily right and left. The two positions show very clearly just how this is handled.

The Allowances of A. S. M. E. Machine Screw Standards

Ever since the adoption of the standard sizes for machine screws by the American Society of Mechanical Engineers, there has been a growing feeling in many quarters that the limits allowed for tolerances were much too large for good commercial work. One inspector in a tap factory protested against allowing a copy of this table to go to the men in the shop for fear of its demoralizing their ideas as to the accuracy that was necessary in their work.

One unfortunate feature of this work is that we must not only have the diameter right, but the sides of the threads must be at the right angles to each other and to the axis of the tap. The diameter is comparatively easy to measure but the angles are an entirely different matter, and there seems to be no accurate method of measuring this that is practical. In fact, comparison seems the only way to get at the matter with any degree of accuracy and this depends on the carefulness of the inspector and cannot be done rapidly at best.

The accompanying table shows the minimum pitch diameters adopted by one tapmaker who has paid careful attention to this detail of the question. A comparison with the A. S. M. E. table will show considerable variation in some sizes. The idea seems to be rather general that these allowances might well be considerably reduced with advantage to all concerned.

Gage.	Outside Diameter	Number of Threads per Inch.																
		80	72	64	56	48	44	40	36	32	30	28	24	22	20	18	16	14
0	0.062	0.0528	0.052	0.051	0.0496													
1	0.075	0.0658	0.065	0.064	0.0626	0.0608												
2	0.088	0.0788	0.078	0.077	0.0756	0.0738	0.0725											
3	0.101	0.0918	0.091	0.090	0.0886	0.0868	0.0855	0.0842										
4	0.114	0.1048	0.1040	0.103	0.1016	0.0998	0.0985	0.0972	0.0955	0.0933	0.092	0.0904						
5	0.127	0.1178	0.1170	0.116	0.1146	0.1128	0.1116	0.1102	0.1085	0.1063	0.105	0.1034						
6	0.140	0.1308	0.1300	0.129	0.1276	0.1258	0.1245	0.1232	0.1215	0.1193	0.118	0.1164						
7	0.153	0.1438	0.1430	0.142	0.1406	0.1388	0.1375	0.1362	0.1345	0.1323	0.131	0.1294						
8	0.166							0.1492	0.1475	0.1453	0.144	0.1424						
9	0.179							0.1622	0.1605	0.1583	0.157	0.1554	0.1517	0.1493	0.1464	0.1428	0.1384	0.1327
10	0.192							0.1752	0.1735	0.1713	0.170	0.1684	0.1647	0.1623	0.1594	0.1558	0.1514	0.1457
12	0.218							0.2012	0.1995	0.1973	0.196	0.1944	0.1907	0.1883	0.1854	0.1818	0.1774	0.1717
14	0.244							0.2272	0.2255	0.2233	0.222	0.2204	0.2167	0.2143	0.2114	0.2078	0.2034	0.1977
16	0.270							0.2532	0.2515	0.2493	0.248	0.2464	0.2427	0.2403	0.2374	0.2338	0.2294	0.2237
18	0.296							0.2792	0.2775	0.2753	0.274	0.2724	0.2657	0.2663	0.2634	0.2598	0.2554	0.2497
20	0.322							0.3052	0.3035	0.3013	0.300	0.2984	0.2947	0.2923	0.2894	0.2858	0.2814	0.2757
22	0.348							0.3312	0.3295	0.3273	0.326	0.3244	0.3207	0.3183	0.3154	0.3118	0.3074	0.3017
24	0.374							0.3572	0.3555	0.3533	0.352	0.3504	0.3467	0.3443	0.3414	0.3378	0.3334	0.3277
26	0.400							0.3832	0.3815	0.3793	0.378	0.3764	0.3727	0.3703	0.3674	0.3638	0.3594	0.3537
28	0.426							0.4092	0.4075	0.4053	0.404	0.4024	0.3987	0.3963	0.3934	0.3898	0.3854	0.3797
30	0.452							0.4352	0.4335	0.4313	0.430	0.4284	0.4247	0.4223	0.4194	0.4158	0.4114	0.4057

MINIMUM PITCH DIAMETERS OF MACHINE SCREW TAPS.

Automobile Show of Licensed Manufacturers

The tenth National automobile exhibition of the Association of Licensed Automobile Manufacturers was held in Madison Square Garden from January 8 to 15 inclusive. This was the largest and best exhibition that has so far been held by this association. In it there were exhibited 42 makes of pleasure vehicles, a few of which were electric; 12 different makes of commercial vehicles, while the makes of motor cycles numbered 23 and the accessory exhibitors, 243. The pleasure cars ranged in price from $750 to $7500 and offered a wide range for choice in the design and type, from the closed limousine to the small runabout.

The Matheson was the only car that placed their cam shaft on top of the engine cylinders, and this they only do on their make-and-break spark engine, it being located in the crank case on the jump-spark engine; which is the universal practice with all the other cars shown. Their cam shaft is also noted for its big cams and roller, and the whole car for its massiveness in design which gives it the appearance of great strength. The development and improvement in tires which enables them to be made puncture proof by the use of bullet-proof cloth on the rim, and also makes them wear longer, has enabled the wheels to be made larger each season until the largest has been named the "Jinricksha."

Several of the cars showed battleship or torpedo bodies. These are usually made of sheet metal that surrounds the entire body, and incloses both seats to a considerable hight. The extreme design of this style of body brought the front and sides up to about the level of the shoulders of the passengers. This protects them from winds and storms and at the same time leaves their view of the road and surrounding country unobstructed.

The Winton car retains its self-starting device owing to its simplicity. The driver simply opens a valve on the dash and this starts a rotary valve that is accurately timed and operated by the cam shaft. This valve has one elongated slot through which the pressure air rushes in upon each successive piston, thus forcing them down in turn and keeping the entire crank mechanism in operation until the occurrence of a spark ignites and starts the motor on its work. This air pressure is obtained by storing in the tank a minute part of the combustion pressure, diverted from two of the six cylinders.

An examination of the engines used showed a tendency toward a longer stroke in order to secure longer-lived motors, higher efficiency and smoother running with more quietness, as the longer the stroke the slower the motor can run and still deliver its full power. This also gives a greater hill-climbing ability. The motor has also been quieted by perfecting the valve-operating mechanism, and improvements in the carbureter-valve settings have increased its flexibility. The water jacketing and lubrication have been improved to an extent that makes it no longer excusable to have an overheated motor. The use of the magneto is fast reaching the point where it should be classed as the universal source of ignition current.

In the transmission the cone clutch has been greatly improved, and the multiple-disk types are growing in favor. Through the use of special steels and special tooth forms, the annular type of ball bearings and gears always in mesh, with the changes made by means of dog clutches, the gear boxes have been made quiet and have been reduced in size.

The live rear axle with the driving mechanism entirely inclosed has become almost universally adopted, and is the most positive and reliable unit in the automobile. Although the pressed-steel frame is but little more than five years old, it is now used on all motor cars. One-piece drop-forge I-section front axles have become the standard. The springs are being made of better material, many using special alloy steels. They have also been lengthened and flattened, especially the rear springs and this makes the cars more easy riding.

The motor trucks were shown in larger numbers and greater variety than at any previous show and are fast coming into prominence for delivery purposes, especially in cities.

In the accessories department was shown a novel combination tool, designed especially for private garages, that was named the Universal. Both sides of this tool are shown in the line-cut, Figs. 1 and 2. At *A* is located a forge that is given its blast, through a tube leading to the central hole, by a small fan inside the tool at *B* that is operated by the crank *C*. On the opposite side is located an emery wheel *D*, that is also operated by the crank *C*. This same crank *C*, through bevel gears, also drives a chuck *E* that will hold drills or similar tools for machining work, while the handwheel *F* can be used to feed the work up to the tool. The chuck can be taken out and the pipe grips *G* and *H* inserted in this hole and another one opposite and the tool used for a pipe vise, while an ordinary machinist's vise is located at *I*. The top and rear end of one vise jaw is formed into a blacksmith's anvil *J*, while an anvil chisel *K* is supplied, to fit in the square hole, for cutting-off work. This tool is sold by Henry Ducasse & Co., Inc., New York. The whole thing weighs 120 pounds and is 12½ inches wide and 46 inches long.

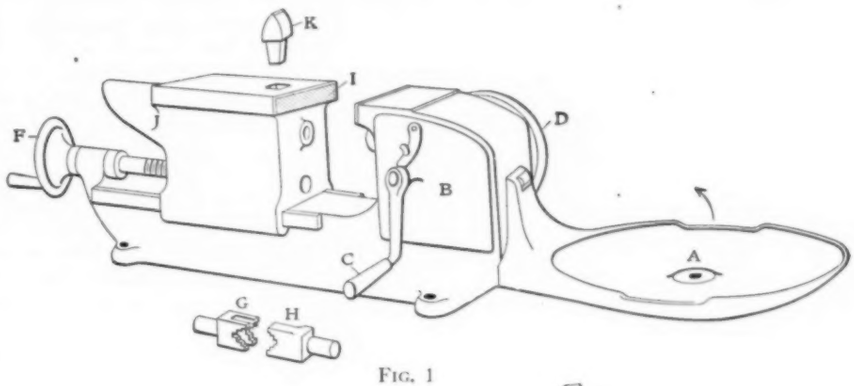


FIG. 1

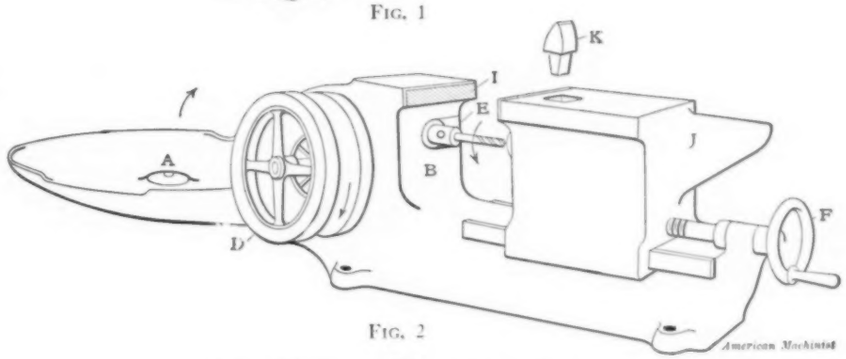


FIG. 2

THE "UNIVERSAL" TOOL FOR GARAGES

Among the other accessories was shown an aluminum solder that is made

by the Reinhold "No Flux" Aluminum Solder Company, Newark, N. J. Samples of work were shown that had been soldered for over five years and presented a perfect joint with no signs of disintegration. This solder is very useful for aluminum pattern work, as well as for general repairs and other kinds of work.

Most of the castings, pressed, stamped, forged and rolled steels, as well as the die castings and many other kind of accessories that were exhibited at the Grand Central Palace Show, the week previous, were moved over to this show and exhibited.

Meetings for Discussion of Shop Problems

By J. A. Miller

A very satisfactory system of holding meetings for the discussion of matters of interest to the foremen is followed at the works of the Landis Tool Company, Waynesboro, Penn.

The meetings are held the first Monday of each month in one of the offices suitable for the purpose. The superintendent, the master mechanic, the jig draftsman and all foremen of departments, including the foremen of the foundry, pattern shop, drawing room, and order department, are expected to be present, and the general manager, the highest official about the works, sometimes attends to offer encouragement or suggestions that may be of value to the foremen. To prevent absences due to forgetfulness on the part of the foremen, each is personally notified by telephone a few minutes before the closing hour of the day on which the meeting is to be held.

The superintendent presides. No attempt is made to conduct the meetings in accordance with parliamentary rules, and the freest possible discussion is encouraged. A competent stenographer from the office is present and complete notes of the proceedings are taken, to be typewritten, a copy being delivered to each foreman.

Time for Consideration

Suggestions or criticisms as originally made are entered on the minutes without comment or discussion, and as each foreman receives a copy of the minutes the suggestions which it contains remain before him as food for thought until the next meeting, when they are read section by section, and it is during the progress of this second reading that the discussions take place. During the intervening month a foreman may have thought of some serious objection to the suggestion offered, or a strong argument in its favor may have been presented to his mind, and when the matter is again brought up the arguments for and against the proposition are pretty thoroughly presented by one or another of the 21 foremen present.

We think this period of time between the making of the original suggestion and its discussion is the key to the success of the plan, as the foremen have had time to think over the problems presented and have had opportunity for forming intelligent opinions of their own.

Any matter touching upon shop work may be discussed. Gear cutting, grinding problems, machine speeds, the handling of men, neatness and order in the shop, errors and inaccuracies in machine work, allowable limits of variation from standard, defects and weaknesses in the shop system, are examples of the matters that have recently received attention. Changes in method are frequently suggested and carried into effect with a resultant saving of time and consequent reduction of cost. The foreman of one of the lathe departments, for example, recommended a change, which, when tested, was found to reduce the cost of a number of parts by about 50 per cent. Fieldmen and salesmen returning from their trips tell of their experiences on the road. Any mechanical difficulty they have encountered is described, and if the trouble had its origin in defective material or workmanship, suggestions looking toward a remedy are given. Comparisons of our methods with those noted in other shops are made, and where possible, improvements are carried into effect. If any special word of commendation from users of our machines has been received, it is repeated for the encouragement of our men, thus fostering a pride in our machine and our workmanship, a belief that both are as good as the best, and a determination to maintain a standard commensurate with the reputation of the machine, a very valuable asset for the company. In the same way, and for the same reasons, communications received through the mails, either in the nature of criticisms or praise, are reported for the benefit of the foremen. At one of our meetings a radical change in our system of inspection was suggested. A month later when the subject was opened for discussion there seemed to be so much to be said both for and against the proposition that the discussion continued beyond the time for adjournment and it was necessary to carry the matter over for continuance at the next meeting.

Interest Aroused

The meetings are never dull. As long as the foremen show the interest so far manifested in them there is no probability of such a condition arising, and as the plan has long ago passed the experimental stage with no apparent diminution of interest, that condition would seem to be a very remote possibility.

Our present method of conducting these exercises is the result of a gradual growth, the first attempt being modified from time to time as certain features were found to be unsatisfactory. For example, the meetings were formerly held in the afternoon while the works were in operation; but as this called the foremen away from their departments during working hours, it required only a few meetings to demonstrate its weakness, and the present method of holding them after working hours was substituted. When this change was made it did not seem fair to the foremen to ask them to attend the meetings outside of regular working hours without some compensation, and accordingly they are paid at a rate approximating the usual rate for overtime.

Practical Results Have Followed Adoption of Plan

The practical results of the plan are in no way more strikingly shown than by the fact that at first we found it necessary and profitable to hold the meetings weekly, but as many of the suggestions made at our earlier meetings were carried into effect, criticisms and suggestions became less numerous and the meetings were held bi-weekly instead of weekly, and later, on account of continued improvements resulting from these discussions, only monthly meetings have been found necessary in order to cover all suggestions.

Softening Effect of Time on Steel

A paper presented in the *Physical Review* dealing with the subject of the softening that hard-steel wire undergoes by the action of time points out the well known principle that the lower the temperature the longer it takes to remove the hardness from a piece of hard steel. The process can be hastened to any extent desired by raising the temperature at which the steel is preserved. At the temperature of boiling water, events progress very cheerfully, so that the behavior at higher temperatures than ordinary room temperatures can be predicted after a few observations some months apart. The conclusion reached by the paper is that if by any miracle the tools in Joseph's carpenter shop, at the beginning of the Christian era, had been glass-hard steel, they would now be so soft as to need most decided retempering.

AMERICAN MACHINIST
ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY
JOHN A. HILL, PRES. ROBERT McKEAN, SEC'Y. 505 PEARL ST. NEW YORK

Index

The index to Part 2, Volume 32, is being mailed to all subscribers with this issue. Those who desire an index, and are not on our regular subscription list, can secure one for the asking.

The Injustice of the Proposed Postal Laws to the Engineering World

The present administration seems determined to increase the tax on industry in more ways than one—the latest being the proposed increasing of the rates on second-class mail—newspapers, magazines, etc.

This will not fall upon the publications themselves but upon the subscribers and advertisers.

Up to 1879 the subscriber paid the postage on his paper or magazine at the office where he received it. The new law made the rate two cents per pound and the publishers paid it, in advance; in 1885 this rate was reduced to one cent a pound.

No publisher ever made a penny by it—the benefit was passed on to the subscriber.

The last ten sessions of Congress have worried over the so-called deficit in the post-office department. *There is not now and never has been a deficit.*

This is the only department that earns a cent—the others are all expense.

This is the only department that the whole public comes in contact with or reaps direct benefits from—it lacks a few million dollars of earning its entire cost.

It would show a handsome profit if it got credit for the enormous mail it carries free for the other departments.

It would show a profit, or at least less loss, if it got as good rates from the railroads as the express companies do.

Now here is where you are concerned.

The President and the new Postmaster General have recommended an increase of postage on *part* of the second class—on magazines and periodicals. This paper is classed as a periodical; it is, however, much more of a newspaper than a magazine; it is as much a newspaper as any published; its news is confined to news of a special character for the information of engineers and not of a general character varying from sermons to tips on the races.

They are leaving out the newspapers—those with political influence—it is the magazines they are after—and the great engineering papers get thrown in with them because, forsooth, they have so many advertisements, the very things that create more business both for the post office itself and all the manufacturers who advertise.

Now, the owners of this paper are no tax dodgers; if it is necessary to increase the rates on the second class we will take our medicine with the rest.

However, we object to this proposed class legislation. To this picking out for exemption those papers the Congressmen are afraid of and the heavy increased tax on those who are supposed to be helpless.

The Postmaster General's own figures show that the rural free delivery is the biggest leak of all, but no one wants to stop it. It has done much good to the farming community and is worth to the nation all it costs, but what is its chief function? To deliver letters? No. To deliver to the farmers of the county the nearest daily and weekly papers—the very ones the Government proposes to exempt from the increase of postage.

The daily and weekly newspapers going over rural free delivery routes cost our Government four times as much as other papers delivered at post offices and through carriers. Not only that, newspapers go *free* in the county they are published in.

This paper is denied even the second-class rate in New York and must pay two cents for each by stamps affixed for every copy delivered in its home city.

There is injustice enough—the Government proposes to increase it.

All the little county papers go through the mails practically without cost—their principal circulation is confined to the county.

We ask our readers and advertisers to use their influence with their congressmen and senators to:

First. Insist that there be no division of classes of papers—that all now enjoying the second-class rates shall be treated alike—no class legislation.

Second. That the county free political graft be abolished.

Third. That the post-office department be given credit for all mail carried under frank for other departments or officers of the Government.

Fourth. That if after these things are done and this question approached fairly and with justice, investigation shows it necessary to raise the second class—raise them as far as is necessary.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Subscribers can have address changed at will. Give old and new addresses.

Subscription price $4 per year, postage prepaid, to any post office in United States, United States possessions and Mexico. $5.50 to Canada. $7 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

Hill Publishing Co., Ltd., 6 Bouverie St., London, E. C., will serve all subscriptions for English Edition for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

Maschinenbau, 71 Unter den Linden, Berlin, N. W. 7, all subscriptions for German Edition. Price for Germany 24 M., Austria 29 K., Switzerland 32 Fr., other countries 35 M.

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CIRCULATION STATEMENT

During 1909 *we printed and circulated* 1,209,000 *copies of the* AMERICAN MACHINIST.

Our circulation for December, 1909, *was (American weekly, American monthly, English weekly and German weekly)* 135,750.

January 6	41,250
January 13	30,500
January 20	22,500
January 27	22,500

This paper reaches 41,250 *separate readers each month and* 22,500 *each week.*

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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Ask your national representatives to do *that* by letter and it will have an immense influence for justice.

We don't believe in any "stand pat" policy; let Congress be fair and do its duty even if it does hurt someone.

Any congressman who will not vote to abolish the county free graft is afraid for himself—that's all.

Nothing but cowardice or ignorance will make representatives of the people vote a high rate on an engineering newspaper and a lower one on a political newspaper. One perhaps has a longer average haul, but the other uses the rural free delivery at great cost to the whole people.

Then think of the farm papers, hundreds of them, all teaching the farmer better methods, economies and putting him in touch with all the latest inventions that he can use to an advantage.

These papers have done and are doing more good and reaching ten times as many farmers as the whole agricultural department on which we spend millions.

And it is proposed to increase the rates on these papers an amount, in some cases, equal to their subscription price—which is very small.

England carries her papers at one cent each. Canada carries hers at one-half cent per pound for 500 miles and one cent everywhere else.

Has this great nation to acknowledge that its post-office department is so grossly mismanaged that it cannot make both ends meet at rates already higher than its neighbor's? There are abuses. Well, if there are novels and mail-order papers improperly admitted to the mail, weed them out; but do not punish the entire reading public of our country—because the poor devil of a publisher cannot carry the load and must push it on to his readers and advertisers.

Again this is a tax on enterprise. Advertising is part of our great commercial system. This would increase its cost.

Write your representative today and ask him to stand on those four foundation stones of justice—and if he is honest he will.

Systems and the Individual

We are all too apt to underrate the importance of the individual in the belief that the modern systems and methods have made him an insignificant part of a great machine. But the individual is just as necessary as ever and the more individuality he possesses the better for all concerned.

Systems and methods are all right for recording what has been done and for following up the production of any work along predetermined lines, but no system on earth ever did or ever will produce a new way of doing work, or a new piece of work to be done. It may be an incentive which urges the individual to better things, but the new idea must come from the mind of the individual in every case.

If every man in the shop could be impressed with this fact, could be made to see that the system in force was simply to keep track of work and not to make him a part of an unthinking machine, could be made to feel that his individual ideas would always receive attention, whether they could be adopted or not, the results would be very gratifying in most cases.

Here again the individuality comes into play, for men will believe and respond to the individual with tact and sincerity, while a mere printed statement of the same ideas will have little effect.

Let anyone who doubts this, post a notice of a reasonable change in the time or piece rate on a certain job, and let the same notice be given the man verbally by a man in whom the men have confidence. The effect of the two methods can be seen at a glance, and where the first will create dissatisfaction in many ways the second will hardly cause a ripple in the shop.

Personality counts in every line of work that we know of and, instead of making it unnecessary, systems have emphasized its value. Shops which recognize this fact can count on much closer relations in every way, all of which has its effect on the output.

Luncheon to Charles Kirchoff

A noteworthy event in technical journalistic circles was the farewell luncheon tendered to Charles Kirchoff, at the Engineers' Club, January 16, as a testimonial of esteem on his retirement from the editorial management of the *Iron Age*, with which paper he has been identified in an editorial capacity for 22 years.

The luncheon was served in the large dining room of the club house, and was attended by a large and representative gathering of engineers and technical journalists. President Dodge, of the club, presided, and appropriate addresses were made by T. C. Martin, R. W. Raymond, C. W. Cope, H. S. Drinker and John Fritz.

William Baxter, Jr.

William Baxter, Jr., inventor, consulting engineer and technical writer, died at his home in Jersey City on January 12. He was born in Troy, N. Y., on March 8, 1852, and manifested at an early age the inventive genius.

William Baxter, Jr., was a typical inventor in all commendable points. As far back as 1884, when the electric motor was mostly a laboratory possibility, he worked out a line of constant-current motors—the first ever built—and in 1886 established a factory in Baltimore for the manufacture of them. Even before that—in 1883—he appreciated the advantages of inclosing the arc of an arc lamp in an air-tight globe, and took out patents covering such construction. In 1887 Mr. Baxter became interested in the electric-hoist problem, and during the years immediately following he invented and patented some methods and devices which for many years were among the most important of those controlled by the Otis Elevator Company, to whom he sold his patents.

Mr. Baxter was also one of the pioneers in the electric-railway field, and his Baltimore company built an experimental car about 1893 which showed promising features.

During recent years Mr. Baxter became well known to those interested in elevators of any type through his comprehensive articles on hydraulic and electric elevators published in the columns of *Power and the Engineer*.

Personals

Items for this column are solicited.

Leo C. Steinle, of the Gisholt Machine Company, left for Europe on the "Adriatic," January 12. He will be away about six weeks.

Through an error the address of Sprague, Keyes & Jackson, consulting engineers, was given in this column in a recent issue as New York instead of Boston, Mass.

John J. Grant is now acting as consulting engineer for the E. M. & F. Company, with headquarters at Detroit. Mr. Grant is to devote his attention to special machinery and appliances.

Charles A. Schieren, Jr., of Charles A. Schieren Company, sailed January 19 for Europe to be gone a couple of months, during which time he will visit the foreign branches of his company.

Oscar Stegeman has become associated with the firm of Landau & Golden, New York City, mechanical and electrical engineers, and will act as their Western engineer, with headquarters at Milwaukee, Wis.

H. G. Schwoeppe, formerly toolmaker and designer with the Massnick-Phipps Manufacturing Company, Detroit, Mich., has accepted the position of designing engineer with the Wolverine Motor Car Company, Mt. Clemens, Mich.

P. J. Illing, manager of the commercial department of Ludw. Loewe & Co., Berlin, Germany, will arrive in this country about February 1. Mr. Illing intends to visit the principal machinery centers in the United States with a view to making new business connections as well as renewing old ones.

NEW TOOLS and MACHINE SHOP APPLIANCES

Showing New Ideas in Machine Shop Equipment that make it possible to do better work at a reduced cost

Any new or improved machine or shop appliance of interest to our readers will be illustrated and described in this department—the machine-shop news.

A full and detailed description—the device featured—when of special interest and it can appear here before being sent elsewhere.

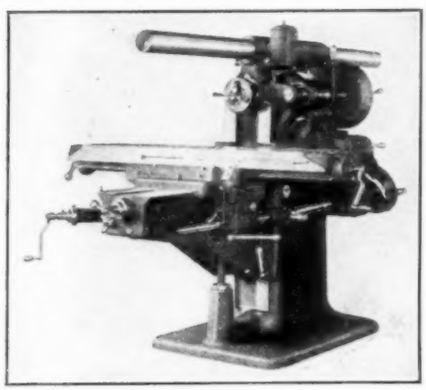
ALL descriptions appear in all four editions of the paper—Weekly, Monthly, Weekly English and Weekly German.

A Jig Boring Machine

The accompanying photo shows a plain milling machine built by the R. K. Le Blond Machine Tool Company, Cincinnati, O., for use in their tool room, in the manufacture of jigs and fixtures.

The arbor is driven by a clutch milled in the end of the spindle nose, and an arbor bolt provides a convenient means of inserting and removing the arbors. The cone is three-stepped, the largest step being 13 inches in diameter for a 3½-inch belt.

The back gears are of the well known double-friction type. Sixteen changes of feed are obtained by a system of tumbler and sliding gears, with only two operating levers close together, and a direct-reading index plate enables the operator to tell at a glance the correct position for a given feed.



A Jig Boring Machine

The table feed is driven with a direct spur drive on the end of the saddle. The reverse and trip for the table feed are operated by a single lever. Large oil pockets extend entirely around the table.

The table feed screw is 1¾ inches diameter, of coarse pitch, and geared 2 to 1 on the quick return, and is always under tension regardless of the direction of movement. The column bearing is extended up almost to the top of the table. The cross-feed screw is set in the center of the knee.

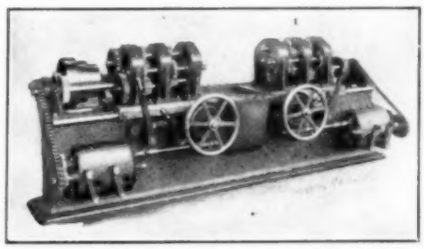
The taper gib for the table bearing is made with a tongue to avoid any tendency to lift. Locking screws with fixed handles are provided on both gibs which draw them in like wedges, and these provide metal-to-metal contacts the entire length of the gibs.

The machine has a longitudinal feed of 34 inches, a vertical feed of 20 inches, and a cross feed of 18 inches. In order to use the machine to the best advantage in boring, the cross feed is arranged in such a manner that its movement can be controlled from the rear of the table. The longitudinal and vertical movements are fitted with vernier scales 24 inches in length.

An interesting feature in connection with the completion of this machine was the testing of the accuracy of the screws. The vernier scales provided an ideal condition for such a test which showed the screws so accurate that the inaccuracy was invisible to the naked eye in a length of 20 inches.

A Boring, Reaming and Facing Machine

This machine is for boring, reaming, facing, etc., the shaft holes in transmission cases for automobiles. It consists of a bed with two saddles, each with five spindles spaced to the center distances required, three spindles of each head having threaded ends, and two having a taper hole in the end.



A Boring, Reaming and Facing Machine

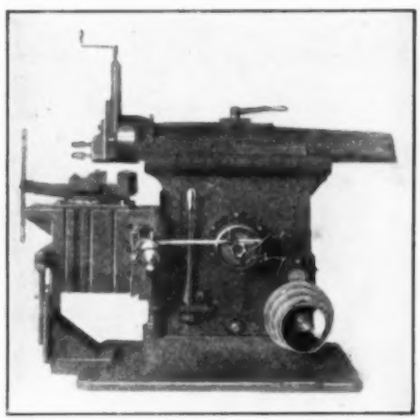
Each head has four independent automatic feeds, of about 2 feet, with automatic stops, also quick power movement in either direction. Each head has independent drive by a belt on a three-section cone geared to each spindle.

The feed is driven by chain and sprockets, and provides four ratios. Shields are provided for all gears.

The bed is provided at the center with extensions, as shown, for receiving suitable fixtures to hold transmission-case castings. This machine weighs 9500 pounds, and is made by the Beaman & Smith Company, Providence, R. I.

A Back Geared Shaper

The halftone shows a 26-inch shaper, one of a new line of these machines which has been brought out by the R. A. Kelly Company, Xenia, O. These machines were designed to use high-speed steel tools to their fullest capacity.



A Back-geared Shaper

The machines are provided with power-elevating devices for the saddles, which can also be used as a power down feed. These machines run from 16 to 26 inches stroke inclusive, and the back-gear ratios run from 24 to 1 on the 16-inch machine to 33.2 to 1 on the 26-inch machine.

A Chain Belt for a Governor

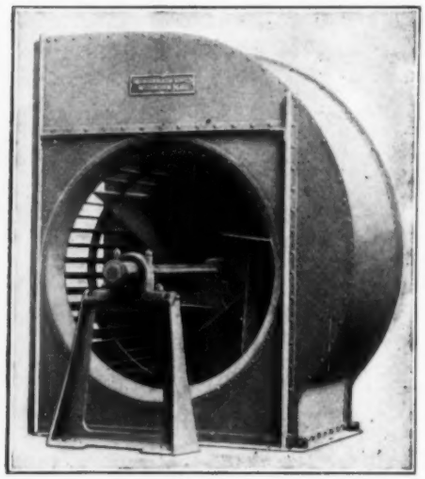
The Diamond Chain and Manufacturing Company, Indianapolis, Ind., recently made a pair of standard roller-type chains to drive the governor of a large compound-tandem engine, 52x90x60 inches stroke.

The engine is capable of delivering 15,000 horsepower and drives a 43-inch blooming mill. The duty of a governor belt for such an engine is very severe but the chains handle the work satisfactorily and require little attention.

A Multivane Fan

The halftone shows a fan which is now being placed upon the market by the Massachusetts Fan Company, Watertown, Mass. The many shallow blades furnish the requisite blade area and permit a large inlet area.

In the early types of "many-blade" fans the removal of all blades in the inlet was an attempt to reduce the eddying effect by restricting to the shortest period possible the time the air is subjected to blade action. As a result a



SQUIRREL-CAGE FAN

high velocity was imparted suddenly to the outer shell of air in the inlet, the velocity being gradually reduced toward the center.

In this fan, known as the "squirrel cage" fan, this defect is overcome by using a few long blades extending toward the center of the wheel, but not radial. The scooping action of the blades starts the air in motion gradually, giving it a slowly whirling motion and then a rapid radial motion toward the small peripheral blades.

Three standard designs of this fan are made, known as types A, B and C, each of which is made in single and double widths.

Type A, for the low peripheral speeds which have been found to be best adapted for public-building work, and for certain conditions for high pressures when the fans may be driven by a direct-connected steam engine.

Type B, for higher peripheral speeds such as those of high-speed motors, especially of the alternating-current type.

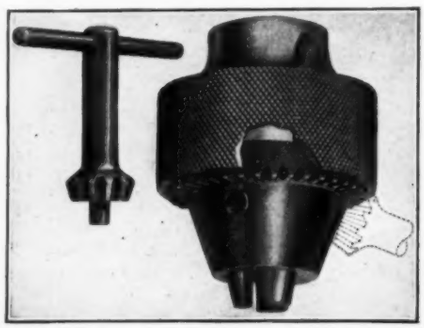
Type C, for very high speeds such as that of steam turbines.

A Pneumatic Hose Coupling

The Caskey Valve Company, 99 John street, New York, is putting a new hose coupling on the market. This coupling is easily attached and detached. The packing is leather and the greater the pressure the more effective the packing becomes.

A Geared Drill Chuck

The halftone shows the new Almond geared drill chuck manufactured by the



A GEARED DRILL CHUCK

T. R. Almond Manufacturing Company, Ashburnham, Mass.

In this chuck all parts subject to wear such as the jaws, toothed split-ring nut, toothed key and the bushings which steady the key in the body of the chuck, are of tool steel hardened and tempered.

Two Forge Blowers

It has been customary in many shops using compressed air for various purposes, to turn a jet of air into the fan

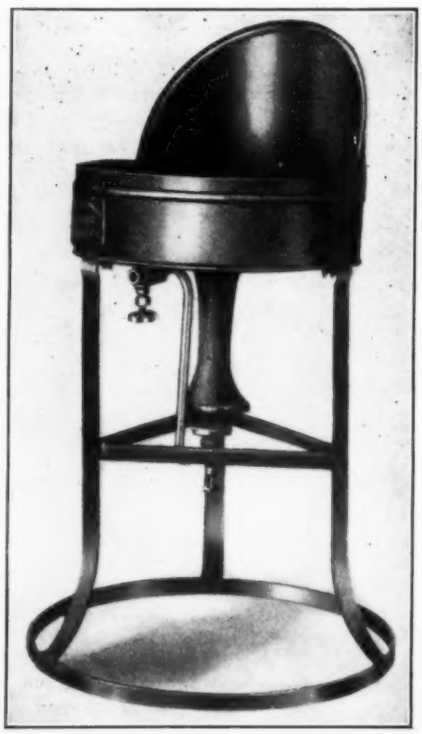


FIG. 1. FORGE WITH AIR-JET BLOWER

or blower of the forge and let it be distributed by the fan to the fire instead of going in as a solid jet and tearing the fire.

The forge shown in Fig. 1 has its air apparatus on the principle of an injector, and the jet of compressed air draws in air from the outside, reducing its pressure and increasing the volume so that only about one-quarter of the compressed air is required as where it is used direct.

The old blower for the blacksmith shop was an unknown quantity so far as the consumption of power was concerned.

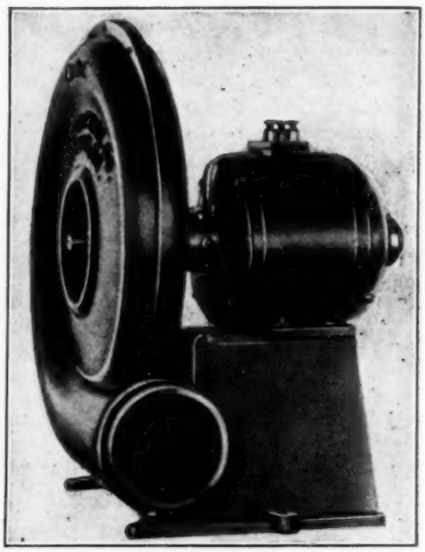


FIG. 2. ELECTRICALLY DRIVEN BLOWER

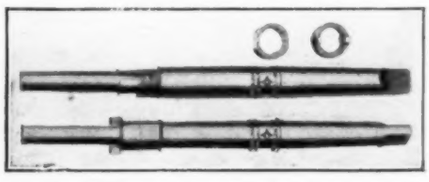
By careful designing, the fan shown in Fig. 2 has been made very efficient both from the point of air delivered and the power consumed in its bearings. The small motors shown vary in size from 1/32 to ½ horsepower and the fan for a blacksmith's forge can be run from a lamp socket where electricity is available.

These two appliances are among the latest products of the Buffalo Forge Company, Buffalo, N. Y.

An Arbor for Shell Tools

The Cleveland Twist Drill Company, Cleveland, Ohio, is about to place on the market the new arbor for shell tools shown in the halftone.

This arbor is equipped with an adjust-



AN ARBOR FOR SHELL TOOLS

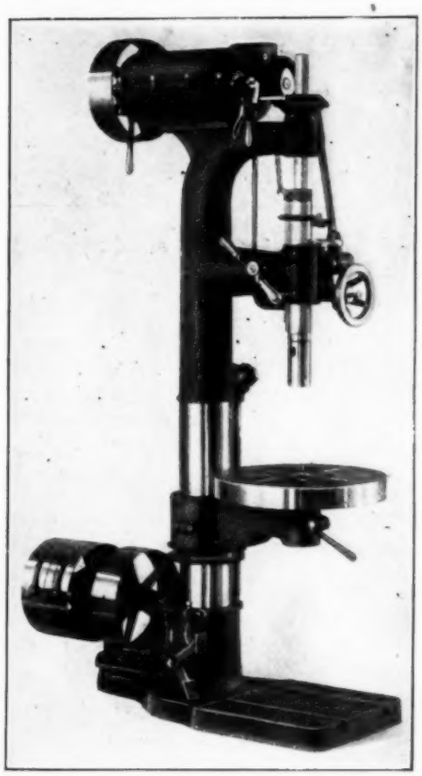
able collar provided with integral keys which slide in longitudinal keyways in the arbor. The arbor is also threaded for a short distance to receive an adjusting nut which bears on the collar. The collar engages the shell reamers in the usual way.

A turn or two of the adjusting nut releases the shell tool no matter how tightly it may have become jammed on the arbor.

The collar also can always be set so as to allow the shell tool to fit snugly on the arbor, and yet fully engage with its slots the collar keys.

Sibley Geared Drill

This is a new all geared drill for high-speed work which gives 8 spindle speeds and four positive feeds ranging from 0.0052 to 0.0169 inch per revolution of spindle, the speed gears being at the top of the column and the feed gear down on the arm supporting the quill.



SIBLEY GEARED DRILL PRESS

The speed gearing is selective, so that the desired speed can be had instantly, without going through the intermediate stages. The feeds are operated by the small knob in the center of the hand wheel.

This has been designed especially for automatic work but will handle any manufacturing drilling up to 1¼-inch high-speed drills and to the center of a 22½-inch circle. It is built by the Sibley Machine Tool Company, South Bend, Ind.

Portable Racks

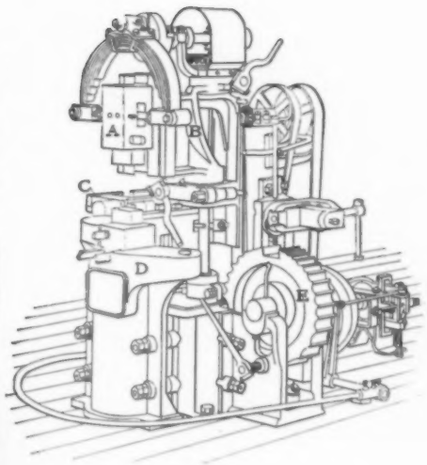
The halftone shows a rack for pipes or bars which has been brought out by the American Die and Tool Company, Reading, Penn. This rack will stand on any level floor and need not be fastened. It is 47 inches high and the base has a spread of 12x17 inches. The openings are 11 inches, and each one of them will hold about 15 round bars 2½ inches diameter; the weight is about 115 pounds.

PORTABLE RACKS

A Radial Power Hammer

The line-cut shows a power hammer designed to enable a blacksmith unassisted to do all operations usually done with the aid of a helper.

The head *A* is mounted on a bracket *B* which swings through 180 degrees so that it can be brought above the vise *C*, the anvil *D*, or the swage block *E*. As will be seen, the swage block is circular and has all the usual sizes of squares and rounds in its periphery. This combination permits all the usual hammering, bending and swaging operations to be done without the aid of a helper. The head weighs 75 pounds; the vertical adjustment is 15 inches; horsepower required 3; floor space necessary 4 feet by 6 feet 6 inches.



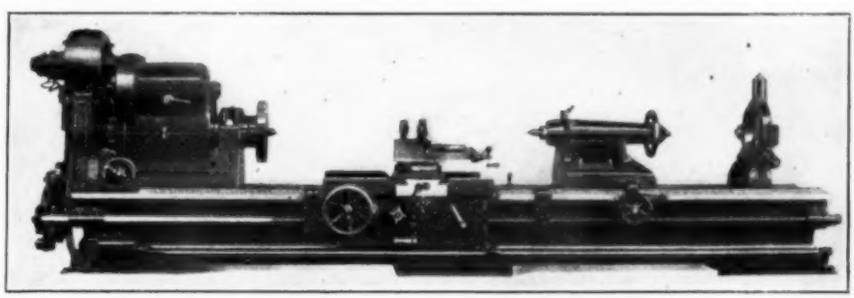
A RADIAL POWER HAMMER

This machine is made by the Radial Power Hammer Company, Los Angeles, California.

Motor Driven 36-inch Engine Lathe

This is a 36-inch by 18-foot motor-driven lathe with a 7½-horsepower variable-speed motor. The headstock is completely inclosed, and contains six mechanical changes of speed, which, together with motor changes, give all the necessary speeds. It is arranged to cut threads from 4 inches to 1/16 inch lead. There are power feeds for longitudinal, cross and angular feed to the compound rest.

The dial in front of the head gives three changes of feed for screw cutting with two intermediate positions where the lead screw remains stationary. This and a few change gears give all the

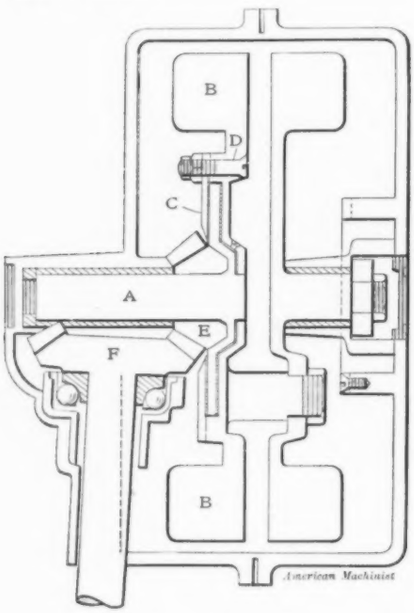


MOTOR-DRIVEN 26-INCH LATHE

necessary changes of feed for screw cutting ordinarily required. It is made by the Springfield Machine Tool Company, Springfield, Ohio.

A Shock Absorber

The line-cut shows a device for absorbing the shock due to the first explosion of an engine as applied to motor cycles but which can be adapted to other transmission mechanism where the start is sudden.



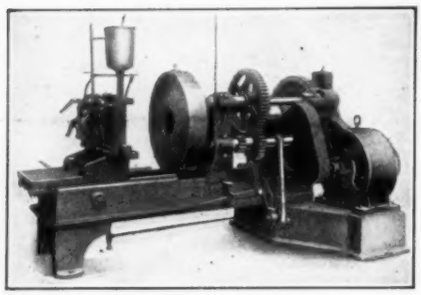
A Shock Absorber

The driving shaft *A* is frictionally engaged with the flywheel disk *B* by means of the friction ring *C* held and adjusted by six screws *D*.

When the first explosion of the engine takes effect on the crank pin, the friction device permits the flywheel crank disk to slip and the full shock of the explosion is thus not transmitted instantly to the teeth of the gears *E F*, but they come gradually to speed. This device is made by the S. D. Manufacturing Company, 155 Ridgewood avenue, Brooklyn, N. Y.

A Pipe Threader Driven by a Variable Speed Motor

The halftone shows a Westinghouse type SA variable-speed direct-current motor driving a machine for cutting and threading pipe from 2½ to 8 inches in diameter, built by the Cox & Sons Company, Philadelphia. These machines are designed in sizes to handle pipes up to 18 inches internal diameter, and where quick changes in speed may be required the special motor drive supplied has proved especially satisfactory.

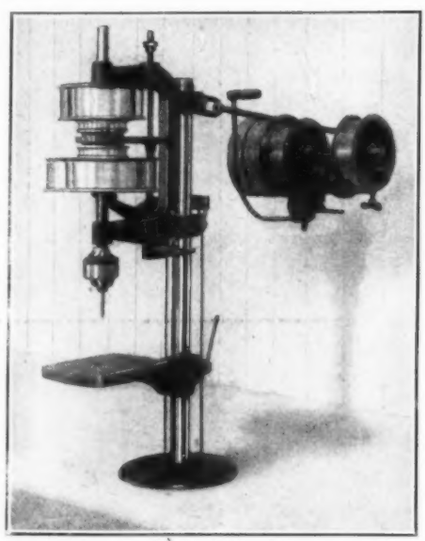


A Pipe Threader Driven by a Variable-speed Motor

This type of motor, built by the Westinghouse Electric and Manufacturing Company, Pittsburg, Penn., gives a speed-variation ratio of one to four.

A Bench Tapping Machine

This machine is intended to use ordinary taps up to ⅜ inch diameter. The clutch pulleys on the machine are of aluminum, for the sake of lightness, and are bushed with suitable bearing metal. The wearing parts of the clutches are of steel hardened. The extreme travel of the spindle is 1½ inches which can be adjusted down to zero by means of the thumb nut on the top of the machine. The clutch is engaged either by a hand pad or by a foot-operated treadle, neither



A Bench Tapping Machine

one interfering with the other; the foot lever is more convenient for most work as it leaves both hands free. The countershaft bolts to the wall and is provided with a belt-tightening device and spring shipper.

The machine, which is equipped with a Skinner geared key chuck, will tap to the center of a 12-inch circle; the maximum distance from the chuck to the table is 7¾ inches.

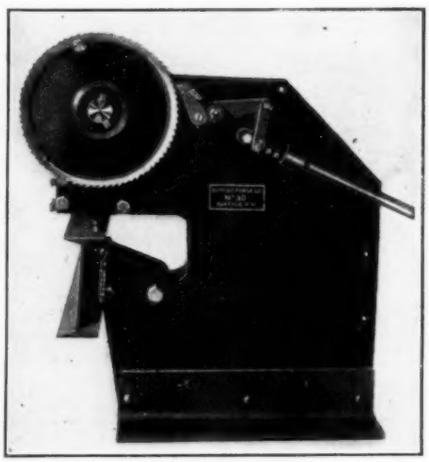
This tapper is made by S. A. Stewart Company, Waltham, Mass.

Crank Case Drill

The Rockford Drilling Machine Company, Rockford, Ill., has modified its horizontal drilling machines so as to make them especially adapted for automobile crank-case and similar work. This has been done by extending the table on base and rearranging the feed to suit the material, which is usually aluminum.

A Ratchet Driven Punch

This is one of the most powerful hand-operated punches made, due to the combination of levers shown and the use of a ratchet wheel of large diameter.



Ratchet-driven Punch

There is a handle near the rim of the ratchet wheel by which the punch can be run down to the work or drawn back very rapidly, and when the pawl is thrown into the ratchet, the desired power can be applied to the wheel and the punch.

It is made by the Buffalo Forge Company, Buffalo, N. Y.

Old Age Pension

There has been introduced at the present session of Congress a resolution for the establishment of a committee of Congress vested with due authority to collect and compile all information extant in order that the way may be paved, not only for the introduction and passage of an old age pension bill, but to insure the framing of a fair and humane constitutional law, in harmony with the spirit of our governmental system. The resolution has been introduced by Representative Lundin, of Illinois, who, in argument for its favorable consideration, points to the fact that after years of consideration of this subject, and a prolonged conflict of ideas, England adopted an old age pension law in 1908, which became effective January 1, 1909.

INCREASING · SHOP · CAPACITIES

where More Tools will be needed

H. E. Cooley will build a box factory at West Bend, Wis.

E. C. Post Company, Lake City, Minn., will erect a tile factory.

The American Pump Company will erect a plant in Elyria, Ohio.

The Detroit (Mich.) Stove Works will erect a new five-story factory.

The Richmond (Va.) Forgings Corporation is to erect a new plant.

The Sheboygan (Wis.) Couch Company will erect a four-story addition.

The Sheboygan (Wis.) Evaporated Milk Company will erect a plant.

The Oscar Lear Motor Company will erect a plant in Springfield, Ohio.

The Piedmont Buggy Company, Charlotte, N. C., will erect a new plant.

The Agasote Millboard Company, Trenton, N. J., will erect an addition.

The Eletric Cable Company, Bridgeport, Conn., will build an addition.

William Rahr Sons Company, Manitowoc, Wis., will enlarge its brewery.

The Brookville (Ind.) Furniture Company will erect a four-story addition.

The Jamestown (N. Y.) Metal Furniture Company will enlarge its plant.

The Rochester (N. Y.) Box Company has purchased site for a new factory.

Sauer Bros., Aberdeen, S. D., cigar manufacturers, will erect a new factory.

The Evansville (Ind.) Veneer Company will build a plant in Jackson, Tenn.

The American Furnace Company, St. Louis, Mo., will erect a new factory building.

Mattson & McGillvray, Black River Falls, Wis., will erect a cement block factory.

Embalmers Supply Company, Westport, Conn., will purchase some new machinery.

The shop of the Victor Tool Company, Waynesboro, Penn., was destroyed by fire.

The Armour Packing Company will erect a cold-storage plant at Port Arthur, Texas.

The Detroit (Mich.) Lubricator Company has let contract for the erection of a foundry.

The Prothero-McGinnis Auto Company will erect an auto-machine shop at Baraboo, Wis.

The Saskatoon (Sask., Canada) Milling and Elevator Company will erect a new flour mill.

J. H. Williams Company, Brooklyn, N. Y., is considerably enlarging its drop-forging plant.

The Falls Machine Company, Sheboygan Falls, Wis., will increase the capacity of its plant.

The Knoxville (Tenn.) Basket and Crate Company will double the capacity of its plant.

The St. Louis (Mo.) Basket and Box Company will spend $60,000 in enlarging its plant.

The Freyer Trunk Manufacturing Company, Houston, Tex., will build a three-story addition.

The New York Baking Powder Company, Jersey City, N. J., will erect a new $75,000 factory.

The Capitol Brass Works, Detroit, Mich., has let contract for the erection of a new factory.

The Cadillac (Mich.) Chemical Company will add a machine shop and make other extensions.

TheAlabama Consolidated Coal and Iron Company is to build a steel plant at Gadsden, Ala.

The People's Railway Company, Dayton, Ohio, will need equipment for new car barns and shop.

The Keneman Paper Company, Montville, Conn., has commenced the erection of its first mill.

The Fulton Engine Works, Los Angeles, Cal., will increase its boiler and machine-shop equipment.

The National Wire Company has secured site in Toronto, Ont., on which a plant will be erected.

The Standard Foundry Company, Hartford, Conn., has commenced the construction of a new plant.

The Burrow, Jones & Dyer Shoe Company, St. Louis, Mo., will erect a factory at Milwaukee, Wis.

The Fostoria (Ohio) Glass Specialty Company will erect a plant at Niles, Ohio, to cost $100,000.

The Niagara Machinery and Tool Company, Buffalo, N. Y., is considering plans for a new machine shop.

The Eau Claire (Wis.) Creamery Company will make extensive improvements to its plant in the spring.

The plant of the Merchants Ice Company, 3082 Emerald street, Philadelphia, was destroyed by fire.

The plant of the American Conduit Company, New Kensington, Penn., was badly damaged by fire.

The Bay City (Mich.) Iron and Boiler Works will rebuild its boiler shop recently destroyed by fire.

Pflugh & Co., Hoboken, N. J., white-lead manufacturers, are to erect a new plant to cost about $50,000.

The Aspinwall (Penn.) Water and Light Company will install new electrical equipment in the near future.

M. Hawle Manufacturing Company, Bridgeport, Conn., making buckles, will build an addition to its plant.

The Omaha (Neb.) Cooperage Company will build a new factory in South Omaha, Neb., in the spring.

The Milbank (S. D.) Cement Construction Company will erect a plant for the manufacture of cement tile.

The Storage Battery and Lighting Company, of Chicago, Ill., will build a plant at Niagara Falls, N. Y.

The Stein Double Cushion Tire Company, Akron, Ohio, has increased its capital and will enlarge its plant.

The plant of the Munro Wire Works, Winnipeg, Manitoba, was destroyed by fire causing a loss of over $75,000.

The Union Spring and Manufacturing Company, New Kensington, Penn., is preparing for extensive additions.

The Adams & Kelly Company, Omaha, Neb., manufacturing sash, doors, blinds, etc., will build a $75,000 addition.

The Nebraska Portland Cement Company is contemplating the erection of a cement factory at Superior, Neb.

French & Hecht, Davenport, Iowa, succeeding the Bettendorf Metal Wheel Company, will erect a new foundry.

F. M. & T. K. Glenn, Liberty, S. C., will establish a plant in Texas for the manufacture of metal shingles.

The Superior Manufacturing Company, Superior, Wis., is building a new power plant. Engine is to be purchased.

The Multi-Blade Razor Company, Madison, Wis., manufacturing safety razors, will install additional machinery.

The Richards Iron Works, Manitowoc, Wis., is said to have plans for an automobile plant to be erected in the spring.

The Hopper-Bowman Company, Philadelphia, Penn., manufacturing boxes, molding, etc., is enlarging its plant.

The Standard Tinplate Company, Canonsburg, Penn., has awarded contract for the construction of a can factory.

M. L. Hewett, Helena, Mont., is interested in a plant to be erected to treat custom zinc ores. Capacity to be 500 tons.

The plant of the Lewiston Clarkson Canning Company, at Lewiston, Idaho, was destroyed by fire. Loss, $34,000.

The Kilbourn Knitting Machine Company, Martinsburg, W. Va., will erect an additional building to cost about $40,000.

The Standard Foundry Company, Hartford, Conn., will erect a new plant. The company manufactures gray-iron castings.

The La Plant Tool Company, Marshalltown, Ia., will expend $25,000 for a plant to build housemoving machinery.

The Oregon & Washington Railway will construct terminal yards and shops at Tacoma, Wash., to cost $1,000,000.

The Lovell-McConnell Manufacturing Company, Newark, N. J., manufacturing electrical supplies, is erecting a new plant.

The Whitin Machine Works, Whitinsville, Mass., building textile machinery, will extend its foundry and blacksmith shop.

The Berkowitz Envelope Company Kansas City, Mo., has had plans prepared for the erection of another factory building.

The Spicer Universal Joint Company, Plainfield, N. J., has taken out permit for the erection of another addition to its plant.

The International Steam Pump Company, Harrison, N. J., will build a three-story addition to its molding and pattern shop.

The power house of the electric-light plant and waterworks at Lethbridge, Alberta, Canada, was burned. Loss, about $50,000.

The Robert Gair Company, Brooklyn, N. Y., paper goods manufacturer, is remodeling its plant. Power capacity will be doubled.

Fire destroyed the planing and woodworking mill at the Pan Handle Shops, Columbus, Ohio, causing a loss of about $10,000.

The planing plant of the Rigermire & Shriver Company, Morgantown, W. Va., was destroyed by fire. Loss, about $50,000.

Gemmill Bros., 618 N. Main street, Los Angeles, Cal., will erect a new shop for the manufacture of gasolene traction engines.

The American Sheet and Tin Company is preparing for the erection of a new box-annealing furnace at New Kensington, Penn.

The Hicks Coal Company, Leechburg, Penn., will install about 15 new cutting machines with electrical equipment in the near future.

Haywood Bros. & Wakefield Company, chair manufacturers, will erect a plant at Thirty-fourth street and Eleventh avenue, New York.

Plans have been prepared for two one-story factory buildings for the Talbert-Whitmore Window Shade Company, Los Angeles, Cal.

The Opportunity Manufacturing Company, Saginaw, Mich., is erecting a plant for the manufacture of knock-down mission furniture.

The Chicopee Manufacturing Company, Chicopee Falls, Mass., will erect a new weave shed to be equipped with modern machinery.

The Concrete Steel Construction Company, Mitchell building, Cincinnati, Ohio, has purchased site on which a plant will be erected.

The Little Crater Company, El Reno, Okla., will establish a factory in Sioux City for the manufacture of the "Little Crater" oil burner.

J. Christiansen & Company, Sheboygan, Wis., have purchased the plant of the National Box and Binding Company. Will enlarge the plant.

The Birmingham (Ala.) Manufacturing Company will establish a plant at Woodlawn, Ala., for the manufacture of steam and hand pumps.

The Watson Manufacturing Company, Jamestown, N. Y., will erect a new plant for the manufacture of its metal and wood fly screens.

The Taplin-Rice-Clerkin Company, Akron, Ohio, manufacturing stoves and ranges, contemplate erecting a new plant to cost about $50,000.

M. J. Gibbud, New Haven, Conn., has purchased site on which a woodworking plant will be erected. This is to cost about $30,000.

The Walker & Pratt Manufacturing Company, Watertown, Mass., will erect a one-story addition to its foundry to cost about $10,000.

The Cudahy Packing Company is preparing plans for four additional buildings at its plant in South Omaha, Neb., including a new power house.

Appropriations have been made for the installation of two new pumping engines at the Ross station of the Allegheny, N. S. Water Works.

The Dominion Motor Car Company, Detroit, Mich., recently organized, will erect a factory. Present address is 24 West Pitt street, Detroit, Mich.

The International Silver Company, Meriden, Conn., will erect another addition to its plant, considerably enlarging the spoon-making department.

The Hydrocarbon Burner and Manufacturing Company, Hoboken, N. J., will erect a plant for the manufacture of engines and oil and gas burners.

Fire destroyed part of the electrical supply plant of the Hansen & Van Winkle Company, Newark, N. J., causing a loss of $20,000. Same will be rebuilt.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., January 25, for 100 all-metal dump cars, as per Circular No. 553.

The National Lines of Mexico, Durango, Dgo., Mexico, are receiving bids for the construction of 100 miles of railroad between Durango and Mazatlan.

The Rome (Ga.) Scale and Manufacturing Company will build a foundry for the production of castings for use in wagon and platform scales, trucks, etc.

The Davidson Bros. Candy Company, Des Moines, Iowa, is negotiating for more ground with the intention of erecting an addition to its plant in the spring.

J. M. Koehler Company, Sheboygan, Wis., manufacturing enameled ware, etc., will make enlargements and improvements to its plant, including a new power plant.

The Republic Iron and Steel Company will require considerable new equipment for a new machine shop to take the place of the one recently burned at Youngstown, Ohio.

The Emerson Steam Pump Company, Alexandria, Va., is erecting a plant to cost about $50,000. Further machinery will be contracted for after the plant is finished.

The Standard Gas and Electric Power Company, Philadelphia, Penn., is inquiring about equipment for the manufacture of an automobile gas engine and small automobiles.

Plans are being made for a railroad from Durango to some point near Fresnillo. For information address W. C. Palmer, Box 17, or F. O. Palmer, Box 62, Zacatecas, Mexico.

Stanley G. Flagg & Co., 424 North Nineteenth street, Philadelphia, Penn., is having plans drawn for an engine house and a gas-producer plant at its plant in Pottstown, Penn.

It is reported the Pressed Steel Car Company, of Pittsburg, has purchased the plant of the Western Steel Car and Foundry Company, at Hegewisch, Ind., and will enlarge same.

Preparations are being made for the new $1,000,000 turbine power plant for the Worcester (Mass.) Consolidated Railway Company, which, it is believed, will be erected in Brookfield.

The Eagle Iron Works, Norfolk, Va., has awarded contract for the construction of buildings at Big Stone Gap, Va., to be equipped for the manufacture of castings and general repair work.

The Whitall-Tatum Company, 46 Barclay street, New York, operating several glass factories in New Jersey, has purchased a plot at Keyport, N. J., on which a rubber goods factory will be erected.

The Youngstown (Ohio) Iron and Steel Roofing Company will use $1,000,000 increase in capital for new mills at its Hazleton plant. Five hot mills and extension to its pressed-steel department will be built.

The Chicago Hardware and Foundry Company, North Chicago, Ill., which recently erected a new foundry, contemplates doubling capacity of its brass foundry and make further additions to its machine shop.

Plans are completed for the reorganization of the Western Iron Mills Company, Denver, Colo., and for the construction of a new and modern plant. The new company will be known as the American Iron Mills Company.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., February 14 for piles, split-sheave pulleys, cold-rolled shafting, car wheels, gear cutters, valves, pipe fittings, etc., as per Circular No. 555.

The Crucible Steel Company has announced that a modern power plant will be built at the Atha works in Harrison, N. J., with mechanical stokers, steam economizers, etc. Additional hammers and presses will also be provided.

It is announced that the Southern California Edison Company is negotiating for a site near Los Angeles for building a power plant, the first cost to be in the neighborhood of $2,000,000, about $10,000,000 to be spent ultimately.

The Birmingham Horseshoe and Rolling Mill Company, recently incorporated, has secured site in Gordon Heights, Ala., and will erect a plant to employ 400 men. M. E. Reed, president and W. E. Shipe, vice-president, both of Middletown, Ohio.

New Incorporations

National Trenching Machine Company, Wilmington, Del. Manufacture trenching machines. Capital, $1,500,000.

Wireless Safety Signal Company, Toledo, Ohio. Capital, $100,000. Incorporators, David T. Davis, C. E. Young, Frank Cook, etc.

Atlantic Manufacturing Company, Lynn, Mass. Manufacture novelties and machinery. Capital, $10,000. Everett A. Collins, president.

Indiana Specialty Works, New Albany, Ind. Manufacture automobile parts. Capital, $10,000. Incorporators, August Kahler, Anton Kahler, etc.

Continental Stoker Company, Chicago. Manufacture boilers, engines, machinery. Capital, 25,000. Incorporators, C. Pekat, W. Pekat, H. Pekat.

Hubbard Steel Foundry Company, Chicago, Ill. Steel and iron castings. Capital, $250,000. Incorporators, J. P. Grier, W. H. Tuttle, N. D. Cross.

Glass Products Company, Newark, N. J. Manufacture glass bottles, etc. Capital, $50,000. Incorporators, L. Sisserson, J. A. Allen, H. L. Burrows.

Caldwell Manufacturing Company, Rochester, N. Y. Manufacture hardware, etc. Capital, $50,000. Incorporators, W. H. Caldwell, E. K. Boucher, etc.

Lotz Auto Company, Lansing, Mich. Manufacture automobiles and auto tires. Capital, $300,000. John A. Lotz, Detroit, is one of the principal stockholders.

Premo Manufacturing Company, Newark, N. J. Stamping and electroplating. Capital, $20,000. Incorporators, B. L. Prenco, C. V. Prenco, William Holzhauer.

Passaic Structural Company, Paterson, N. J. Manufacture iron, steel, etc. Capital, $100,000. Incorporators, Jas. Simpson, Frank C. Reinhardt, J. Barclay Cooke.

Central Zinc Company, New York. Manufacture, smelt and refine metals of all kinds. Capital, $50,000. Incorporators, W. Loewenthal, S. Bernheim, New York, etc.

St. Louis Corrugated Paper Box Company, St. Louis, Mo. Manufacture boxes, cases, etc. Capital, $10,000. Incorporators, H. A. & H. W. Johnson, W. V. Boyne, etc.

Bordentown Forge and Machine Company, Bordentown, N. J. Capital, $50,000. Incorporators, Philip L. Swank, Bordentown; A. H. Burton, R. B. Seyfert, Philadelphia.

Comstock-Wellman Bronze Company, Cleveland, Ohio. Manufacture brass and bronze castings. Capital, $25,000. Incorporators, C. W. Comstock, S. T. Wellman, etc.

Western Implement Company, Indianapolis, Ind. Manufacture agricultural implements and machinery. Capital, $10,000. Directors, J. H. A. Ross, I. M. Ross, C. A. Ross.

Buffalo Tool and Supply Company, 15 Swan street, Buffalo, N. Y. Woodworking machinery. Incorporators, A. B. Kellogg, Chas. Park, Buffalo; Myron Grennell, Waymart, Penn.

Drake-Morrison Paper Box Company, Newark, N. J. Manufacture paper, cardboard, paper boxes, etc. Capital, $50,000. Incorporators, F. W. Smith, H. W. McDavit, M. A. Drake.

Mount Adams Railway Company, 15 Exchange place, Jersey City, N. J. Construct railways. Capital, $500,000. Incorporators, H. O. Coughlin, S. A. Anderson, John R. Turner.

The Ford Refrigerating Air Machine Company, Newark, N. J. Manufacture ice machinery. Capital, $150,000. Incorporators, Henry B. Ford, Anthony Palmer Brill, Chas. M. Horton.

A. F. Flanders Manufacturing Company, Buffalo, N. Y. Manufacture metal fixtures and novelties, metal plating, etc. Capital, $30,000. Incorporators, A. F. Flanders, H. B. Dunning, etc.

Mount Carmel Vitrified Brick and Sewer Tile Company, Mount Marmel, Ill. Manufacture clay products. Capital, $50,000. Incorporators, W. A. Stansfield, J. E. Willis, J. G. Stansfield.

Royal Engine Company, Bridgeport, Conn. Manufacture marine and automobile engines. Capital, $50,000. Incorporators, Frank I. Prentice, Hartford; A. F. Law, H. N. Law, Bridgeport, Conn.

Gilchrist Company, Newark, N. J. Manufacture cork pullers, corking machines, capping machines, ice picks, etc. Capital, $125,000. Incorporators, R. B. Gilchrist, L. G. Gilman, Jas. M. Read.

Akron Rubber Mold and Machine Company, Akron, Ohio. Manufacture rubber tire molds and other rubber machinery. Capital, $10,000. Incorporators, W. D. Morris, W. E. Pardee, Stanley W. Harris, etc.

Bordentown Forge and Machine Company, Fieldsboro, N. J. Mechanical and electrical engineering, machinists, etc. Capital, $50,000. Incorporators, Philip L. Swank, Arthur H. Burton, Roy B. Seyfert.

Shedlock & Hanlon Company, Brooklyn, N. Y. Manufacture and deal in paper. Capital, $10,000. Incorporators, W. J. Shedlock, 447 Prospect place, E. J. Hanlon, 321 Ralph street, Brooklyn, and others.

Sterling Company, Providence, R. I. Manufacture and deal in wares and devices composed of wood, metal, rubber, glass, etc. Capital, $100,000. Incorporators, Frank H. Swan, F. B. Keeney, Wm. A. Spicer, Jr.

Automatic Wooden Box Machine Company, New York. Manufacture machines to make doors, boxes, etc., from wood, metal, etc. Capital, $100,000. Incorporators, W. A. Waldron, R. C. Neff, Brooklyn; J. D. Rishell, New York.

Automatic Wooden Box Machine Company, New York. Manufacture machines for making doors, boxes, etc., from wood, metal, etc. Capital, $100,000. Incorporators, Wm. A. Waldron, 207 Chauncey street, Brooklyn; Robert C. Neff, 397 Seventh street, Brooklyn; J. D. Rishell, 288 West Broadway, New York.

Trade Catalogs

Rogers, Printz & Co., Warren, Penn. Booklet describing wrenches. Illustrated, 3½x6 inches.

Bardons & Oliver, Cleveland, Ohio. Catalog describing turret machinery. Illustrated, 302 pages, 4½x7 inches, paper.

J. E. Hoppen & Sons, 75-79 Main street, Belleville, N. J. Catalog describing grindstones. Illustrated, 16 pages, 5x6½ inches, paper.

The Blake & Johnson Company, Waterbury, Conn. Circular illustrating and describing grinder for die and surfacing grinding.

Gould & Eberhardt, Newark, N. J. Loose-leaf catalog of automatic gear-cutting machines, rack-cutting machine. Illustrated, 8½x12 inches.

The Brown Hoisting Machinery Company, Cleveland, Ohio. Catalog describing Ferroinclave sheets for roofing, etc. Illustrated, 40 pages, 6x9 inches, paper.

International Engineering Company, 1779 Broadway, New York. Catalog of R B F radial and thrust ball bearings. Illustrated, 54 pages, 6x9 inches, paper.

A. D. Quint, Hartford, Conn. Catalog No. 10, describing vertical turret drilling, tapping and chucking machines. Illustrated, 6x9 inches, 24 pages, paper.

B. F. Sturtevant Company, Hyde Park, Mass. Catalog No. 150 describing fuel economizers and air heaters. Illustrated, 30 pages, 6½x9 inches, paper.

Charles H. Besly & Co., 118 North Clinton street, Chicago, Ill. Booklet on Helmet spiral circles and Besly's modern disk grinding practice. Illustrated, 42 pages, 5½x9 inches.

The Garvin Machine Company, Spring and Varick streets, New York. Catalog Edition G, describing spring-coiling machines, cutter and surface grinders, milling machine tool and attachments, pulleys, countershafts, hand lathes, etc Illustrated, 92 pages, 4x6 inches, paper.

Business Items

Hill, Clarke & Co. gave a banquet to the various manufacturers they represent, at De Jonge's café, Chicago, Ill., on January 11. They had a complete representation and after the banquet a theater party was provided for the entire gathering.

The business of Selig, Sonnenthal & Co., London, and Selson Machine Tool Works, Coventry, England, has been taken over by the Selson Engineering Company, Limited, and will be carried on exactly as before and under the same management.

The Toledo Electric Welding Company, of Toledo, Ohio, has increased its capital stock from $30,000 to $75,000 and will move to Cincinnati, Ohio, where it has closed a long lease on a two-story modern brick factory building, 160x60 feet. An equipment of machine tools is being installed and the plant will be in full operation about February 1, manufacturing a complete line of electric welding machines for any kind of work. The officers of the company are as follows: Neil Macneale, president and treasurer; Walter G. Franz, vice-president; Frank Warren, secretary and general manager; and these gentlemen with G. W. Drach and J. A. Muir are the directors of the company. Messrs. Macneale, Franz and Drach are well known Cincinnati business men. Mr. Warren, who has been connected with the Toledo Electric Welding Company since its inception, will move to Cincinnati by the time the factory is ready for operation, and nearly all of the Toledo employes will go there at the same time.

Forthcoming Meetings

Western Society of Engineers, Chicago, Ill. Regular meeting first Wednesday evening of each month, excepting July and August. Secretary, J. H. Warder, 1735 Monadnock block, Chicago, Ill.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's hotel. D. F. P. Clark, secretary, 309 Milk street, Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Tuesday each month. E. C. Bliss, president, 91 Sabine street, Providence, R. I.

American Foundrymen's Association and American Brass Founders Association; joint convention, June 7-8-9, Detroit, Mich.; headquarters, Hotel Pontchartrain. Richard Moldenke, secretary, Watchung, N. J.

National Gas and Gasolene Engine Trades Association. Semi-annual convention, Cincinnati, Ohio, June 13-16, 1910; headquarters, Hotel Sinton. Albert Stritmatter, secretary, Cincinnati, Ohio.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Superintendent, American, wants position; experienced in pattern, machine shop and foundry work, organization and production; location immaterial. Box 141, AMER. MACH.

CONNECTICUT

Mechanical engineer and superintendent wants position as traveling salesman, machine tools or similar line; opportunity of more importance than salary. Address Box 135, AMERICAN MACHINIST.

Tool and die maker with 14 years' experience (6 years in own shop with ordinary machine work, experimental work and special tool work) wishes position to take charge of tool room or similar position with responsibility; can design and make drawings. Box 120, AMERICAN MACHINIST.

ILLINOIS

High grade cost accountant; 10 years' experience; good executive; A-1 references; location not material. Box 132, AMER. MACH.

Mechanical draftsman, four years' experience, desires change; at present checking in a department of twelve men. Box 88, AM. M.

First-class tool designer wants position getting out dies, jigs and fixtures for light automatic machinery or metal specialty work; prefer Chicago or vicinity. Box 116, AM. MA.

Manager or superintendent of manufacturing plant; light duplicate machinery preferred; 25 years' practical experience; gilt edge reference. Box 83, AMER. MACHINIST.

MASSACHUSETTS

Correspondence solicited from parties desirous of securing the services of a high grade mechanical factory manager. Box 118, AM. M.

An American, 40 years old, superintendent; 22 years as die and toolmaker, machine building, cost reducing and up-to-date methods of manufacturing interchangeable parts; a position similar; best of references. Box 98, AMERICAN MACHINIST.

Superintendent or assistant; age 38; wide experience handling large number of men; a first class organizer and executive, full of push and energy; practical machinist and toolmaker; highest references. Address Box 107, AMERICAN MACHINIST.

Young man with good executive and some mechanical ability; 7 years' experience as foreman; at present handling 100 hands, wishes correspondence with concern requiring foreman or assistant superintendent; references exchanged. Box 115, AMER. MACH.

Specialty—Introducing new and improved tools to the trade, machine shops and manufacturing industries in Massachusetts, Rhode Island, New Hampshire and Connecticut by direct representation by experienced machinists and traveling salesmen. Box 102, AM. M.

Works manager or general superintendent invites correspondence from manufacturing concerns desiring the services of a man of proven ability as an organizer and producer, one thoroughly familiar with the business as well as the practical side of large foundry and machine business, accustomed to securing and carrying to completion large contracts. Box 134, AMERICAN MACHINIST.

NEW JERSEY

Technical graduate with seven years' experience on general and special machinery; practical shop experience. Box 133, AM. MA.

An A-1 toolmaker and machinist with good executive ability, well up in tool design, desires an executive position; can produce results economically; similarly employed, but wish to make a change; New York or New Jersey localities preferred. Box 140, AMERICAN MACHINIST.

NEW YORK

Wanted—A position as superintendent of machine shop by experienced man on general work. Box 114, AMERICAN MACHINIST.

First class tool and instrument maker experienced as foreman; good executive, design and practice, desires responsible position. Box 121, AMERICAN MACHINIST.

A-1 machinist, tool and die maker, over 20 years' experience, good in all branches, thorough and competent, desires change out of New York City. Box 117, AMER. MACHINIST.

Experienced foreman, middle aged, modern ideas, now employed, desires change; engineering work, dynamos and steam pumps; A-1 hustler; can handle large force with ability. Box 129, AMERICAN MACHINIST.

Man thoroughly experienced and up to date in modern machine shop methods, familiar with use of high speed steels, desires change; position of superintendent, general foreman, or head department foreman; have good record for past six years as head department foreman; who wants me? I can produce the goods; automobile shop preferred. Address Box 73, AMERICAN MACHINIST.

Successful draftsman, designer; 12 years' experience on automatic machinery, hydraulics, elevators, machine tools, electrical machinery, fixtures, etc.; exceptional ability on practical development of automatic machinery for cheap production of parts, labor saving devices, etc., and a thorough knowledge of modern production methods; a position is wanted where this ability is taxed to the utmost, with some wide awake manufacturing concern; a comparatively low salary is asked where a permanent position with unlimited opportunity for advancement is offered. Box 139, AMERICAN MACHINIST.

OHIO

Factory superintendent, a good producer, experienced in methods of manufacture, handling of men and keeping down costs, desires change; technical graduate; best of references. Box 119, AMERICAN MACHINIST.

PENNSYLVANIA

Designing engineer, graduate; 12 years' experience on special and automatic machinery, typewriters, adding machines; inventive and practical man, is very capable on bringing out new work or improving. Box 138, AM. M.

By a mechanical superintendent and production engineer of large experience; successful in increasing production and reducing cost of manufacturing; good organizer; now holding a similar position, but desire a change; good references. Box 125, AM. MA.

Wanted—A position as superintendent who has had a successful experience in the manufacture of plumbers' supplies and sanitary specialties and general brass goods manufacturing; energetic; good organizer; can obtain highest quality and quantity of work from employees; now employed, but desires a change. Box 126, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Wanted—Skilled toolmakers on punches and dies; steady work; wages from 35c. to 45c. per hour. Apply Canadian General Electric Co., Peterboro, Ont.

CONNECTICUT

Experienced jig and gage designers wanted; steady employment promised. Box 66, AM. M.

Wanted—Experienced mechanical draftsmen for detail work, in a concern manufacturing general rolling mill and hydraulic machinery; state age, experience and salary expected. Box 796, AMERICAN MACHINIST.

DISTRICT OF COLUMBIA

Wanted—First class instrument maker to take second place in shop; must be a man of wide experience and expert knowledge in fine instrument construction; initial pay on the basis of an eight-hour day will be $1000 to $1200 per year depending upon qualifications and experience in instrument shops; applications giving full particulars as to character of apprenticeship and training, instrument making experience and references should be addressed: The Director, Department Terrestrial Magnetism, The Ontario, Washington, D. C.

ILLINOIS

Wanted—Draftsman who has had experience in designing surface grinders; state experience and references. Box 24, AM. MACH.

Wanted—Screw machine and Jones & Lamson operators and toolmakers; good wages, no labor troubles. Velie Motor Vehicle Co., Moline, Ill.

Wanted—Diemakers; high-grade men for small accurate work; toolmakers for gage, jig and fixture work; milling-machine operators for tool-room work; automatic screw-machine operators for Brown & Sharpe and other automatic screw machines; on this line of work we pay competent men 39 cents per hour; added premiums will make this rate average 42 cents per hour; hand screw-machine operators. In answer give full information. Address Department 1056, Western Electric Company, Chicago.

Wanted—Superintendent for factory manufacturing gasolene engines; concern employing about 100 men; must be a thorough executive and must thoroughly understand the subject of gasolene engines; concern is now producing engines at the rate of about 6000 per year; must be familiar with factory system in all departments; technical graduate preferred; in replying give full particulars as to past experience, with whom, salary expected and all other details likely to be of interest. Box 99, AMERICAN MACHINIST.

IOWA

Experienced foreman for machine shop building contractors' equipment; must be thoroughly conversant with modern methods and able to show results in a new and well equipped shop; furnish full particulars in your first letter and you will at least receive an answer. Box 46, AMERICAN MACHINIST.

MASSACHUSETTS

Designer on rotary printing presses and folders. Meisel Press Co., Boston, Mass.

Wanted—Assistant manager to take charge of manufacturing; must be experienced and expert in punch and die work. Address Box 109, AMERICAN MACHINIST.

Wanted—Owing to an increase of capacity we can now use twenty more all-around machinists in a shop near Boston, making light and medium weight machinery; good pay and permanent position for the right men. Box 55, AMERICAN MACHINIST.

We are increasing our force and invite applications from experienced iron and brass moulders, core makers, chippers, pattern makers, draftsmen, production men, machine tool operators (all kinds), brass finishers, polishers, layout men, bench hands, erectors, etc. Heavy and light engine and pump manufacture; works handy to Boston and best evening schools; no labor trouble, and applicants are notified as soon as positions are open; applicants should state age, height, weight and experience in detail. Address Employment Division, Blake & Knowles Steam Pump Works, East Cambridge, Mass.

MICHIGAN

Wanted—Experienced gunbarrel and gun frame bluer. Please state experience, rate of wages expected, etc. Box 3, AMER. MACH.

Wanted—Toolmakers, diesinkers, machinists, automatic screw machine operators; also Jones & Lamson men for setting up; milling machine hands and blacksmiths; first class men only; state age, experience and wages. Apply Buick Motor Company, Flint, Mich.

Wanted—Foreman for machine shop employing about 50 men manufacturing automobile cranks, transmission gears and various auto parts; must be first class man, experienced in automobile and gear work; give experience, references and salary expected in first letter. Box 62, AMERICAN MACHINIST.

NEW JERSEY

Wanted—An experienced man who is a mechanic capable of sharpening cutters, drills and taking general charge of tool room. Box 137, AMERICAN MACHINIST.

Wanted—We desire applications from drop forgers, grinders, polishers and milling machine hands; the work is a line of hardware specialties, and men experienced in this line of work who can prove themselves capable, will be given permanent positions and ample opportunity for advancement. In reply give age, references and salary desired. Box 128, AMERICAN MACHINIST.

Wanted—General foreman for machine shop in plant building high-speed steam and gas marine engines; must be a thoroughly competent mechanic, capable of instructing others, good executive with personality and push to produce results and minimum costs without friction; our business is growing rapidly and offers a good opportunity to the right man. Address giving experience, nationality, age, reference and salary. Box 136, AMER. MACH.

NEW YORK

Wanted—Experienced shipping clerk who understands heavy and foreign shipments, etc. Box 123, AMERICAN MACHINIST.

Wanted—Foreman of rough grinding, polishing and buffing department in a modern shop; we desire a man who is active and who can break in green help. Box 90, AM. MACH.

Wanted—Lathe, planer, shaper and all-around floor hands; no labor trouble, good pay, steady work; state experience and wages wanted to start. W. B. Peirce, North Tonawanda, N. Y.

Wanted—Experienced switchboard and mechanical draftsmen; give age, experience and salary wanted. Apply Engineer in Charge, Drafting Department, General Electric Co., Schenectady, N. Y.

Wanted—Lathe hands, planer hands and floor hands; applicants must state by whom employed, past experience, age and wages expected, to receive consideration. Box 42, AMERICAN MACHINIST.

Wanted—Thoroughly competent mechanic to take position as speed boss; applicant must give full particulars in reference to experience and wages expected in his first letter. Box 43, AMERICAN MACHINIST.

Wanted—Factory superintendent for machine shop and foundry employing two hundred men; one who has had successful experience; good executive with a clean cut record as an earning power. Box 86, AM. MACH.

Wanted — Experienced engineer to take charge of erecting department; must be a thorough mechanic and conversant with Corliss valve gear; state salary expected and when available; give references. Box 85, AMERICAN MACHINIST.

Wanted—Die designer; man who has had experience in the designing of dies for blanking and forming sheet metal; one who has had experience in heavy work preferred; no other need apply. Maxwell Briscoe Motor Co., Tarrytown, N. Y.

Wanted—Practical reamer grinder; one who understands grinding all styles of reamers and must know how to operate grinding machine; give reference and state how long experience and also wages. Box 131, AMERICAN MACHINIST.

Wanted—General foreman of machine shop; must be an active, capable man, and a hustler who can produce results with our present equipment, which is moderate; this position affords excellent opportunities to one who can make good. Box 91, AMERICAN MACHINIST.

Wanted—Man to take charge of small tool and die department in large manufacturing establishment; must be thoroughly familiar with all branches; will also have charge of the up keep of finished stock and tempering; only the best of those so employed at present need apply. Box 127, AMERICAN MACHINIST.

Wanted—Night foreman for grinding department employing 15 men on high-class automobile work; only men who have had experience on the rapid production of accurate work and setting piece work prices need apply. When making application state age, experience, wage wanted, where employed for the past six years, and in what capacity. Applicants must answer all of the above questions in order to receive consideration. Box 130, AMERICAN MACHINIST.

OHIO

Wanted—First-class gas engine erecting engineers, experienced on producer gas installations and preferably vertical multiple cylinder engines; state fully experience and wages. Apply The Foos Gas Engine Co., Springfield, Ohio.

Wanted—Experienced machine designer and checker wanted, by large company building general line of machinery; good opportunity for a thoroughly capable man with wide experience and some executive ability; in reply state age, salary wanted, nationality, names of firms worked for and length of service in each; also give references and any other information calculated to give a correct idea of applicant's caliber. All correspondence strictly confidential. Address Box 6, Station B, Cincinnati, O.

Wanted—First-class machinists, toolmakers die sinkers, lathe, planer, drill press, screw machine, boring and milling machine operators, wood patternmakers, brass molders, polishers, buffers, finishers, spinners, millwrights, hammermen and blacksmiths who are seeking positions or desirous of improving on those which they have, to register their names and addresses with the free Employment Department of the National Metal Trades Association. Address Commissioner's Office, 605 New England Bldg., Cleveland, O.

PENNSYLVANIA

Wanted—Four A-1 operators on Brown & Sharpe screw machines on delicate interchangeable small parts; manufacturing establishment located in eastern Pennsylvania; applicants must state experience, wages and references; for three months these positions will be on the night gang, after that, day work; 55 hours per week; no triflers, first class mechanics only considered. Box 124, AMERICAN MACHINIST.

WISCONSIN

Draftsmen—A few experienced and reliable mechanical and structural draftsmen wanted immediately. In applying state age, salary expected and technical education. The Bucyrus Co., So. Milwaukee, Wis.

For Sale

For Sale—One 1-inch two-spindle Foote-Burt bolt cutter; good as new; used only a few months. Rock Island Mfg. Co., Rock Island, Ill.